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CONTENTS.

	PAGE.
The Use and Misuse of Land	1
Collection and Classification of Crop Varieties and Related Species	3
Problems connected with Root Disease of Sugar-Cane in Antigua	5
Some Worm Parasites of Stock in St. Lucia	8
West Indian Notes	9
Coffee Consumption	11
Further Notes on the Food and Habits of Trinidad Birds with special reference to common cane field Birds	12
Elephant Grass	18
Investigations on Sugar-Cane and Sugar-Cane Soils in Antigua	19
Reviews	24
Sugar Notes	26
Chemical Notes	27
Trend of the Markets	28

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Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE USE AND MISUSE OF LAND.

"The land was made for the people."

THE recognition of private ownership of land is by no means common in tropical countries, where the bulk of the land is still held as the common possession of the tribe or clan, and provides sites for shifting cultivation, which is characteristic of such conditions, or for the grazing of the individually-owned flocks and herds of the community.

An exception to this state of things is India, where individual titles to land are clearly recognised, but where such titles carry with them the necessity for payment of assessment. Land which is not worth cultivating is not taken up. The reason for non-cultivation is not always poverty of soil, but may be unhealthiness, elevation or remoteness from communications. Portions of such areas may be retained as forest reserves either for the production of valuable timber, fuel and fodder, or as a protection of river sources. There is, however, much land which is both non-cultivable and unsuitable for forest purposes, and which is vaguely described as Government waste land.

This waste land resembles the common land described, in that it is no one's business to look after it and it is therefore liable to serious misuse. It is not so much a question of misuse as over-use—light use, even on incorrect lines, does little damage—but heavy use, more general now owing to the increasing pressure on the land, brought about by restriction of areas or increase of population, is responsible for very serious results.

A recent Oxford Forestry Memoir* throws a striking light on this misuse and shows not only how serious it is, but indicates also remedies which should be put into effect to mitigate it or prevent it entirely. The author, Dr. Gorrie, of the Indian Forest Service, was able, through the generosity of the Leverhulme Research Fund, to spend four months touring in the United States in order to collect information about "The correlation of erosion damage and grazing in forest lands", but the present memoir is rather wider in its scope,

* The Use and Misuse of Land. By R. Maclagan Gorrie, D.SC., F.R.S.E. Oxford Forestry Memoirs, No. 19, 1935. *Oxford University Press, Amen House*, E.C.4, pp. 80. Price 6*s*. net.

and deals with the damage brought about both by grazing and by shifting cultivation. In either case this damage is caused by the destruction of the natural vegetal cover, which once destroyed is difficult, almost impossible to replace. It is common knowledge that the loss of this cover leads to erosion, (1), with the consequent evils of loss of soil, flooding, silting up of rivers and irrigation schemes. Which, on the whole, is responsible for the greater damage to this cover, over-grazing or over-cultivation is difficult to say, probably the former, it may at any rate be considered first.

Sooner or later, over-grazing is bound to occur, when, as Dr. Gorrie says, the grazing is managed on a system of "first come, first served", and equally certainly, over-grazing is bound to lead to the destruction of the plant cover. From his experience as an officer of the Indian Forest Service, and from what he was able to see in the United States, where the dangers of over-grazing are in places fully realised and where action is being taken, the author is able to quote some very striking instances, backed, where the United States is concerned, by a number of excellent photographs. One of these, an aerial view of Navajo grazing country deserves special mention.

His remedy is the control of these areas by some public body for the benefit of the community as a whole. The correct grazing of land must be planned and not left haphazard. A grazing capacity survey must be made, which will take into account the local flora, its palatability, its reaction to grazing, the water requirements of the stock to be grazed and the presence or absence of predaceous animals. The last point is one of real importance, because where stock are liable to suffer from the depredations of wild animals, they will have to be concentrated at night, and this leads to the formation of cattle tracks, which start gullying. The drought commission in South Africa (2) found that the jackal was in this way largely responsible for the reduction in the quality of the pastures.

When the carrying capacity of the pasture has been ascertained, and this is liable to revision at any time owing to its improvement or deterioration with varying seasons, the control must be put into force, and this will not be a popular measure, for it implies restriction and the compulsory disposal of surplus stock. Moreover, as Dr. Gorrie points out "Under most so-called 'popular government' systems, the long view necessary for sound forestry and land-use planning is apt to be sacrificed to temporary gains, or to the force of political pressure".

The problem must however be faced and without delay. There are areas in all our tropical colonies, where the damage is already serious, and where it is rapidly growing worse. Stockdale (*loc. cit*) describes the overstocked grazing areas of Tanganyika and Kenya as not only over-grazed but grossly over-trampled, especially during the dry season. This reduces the soil to a powder which is either blown by the wind or washed away with the first rains. As soon as the grasses spring after the first rains they are ravenously devoured and no satisfactory growth of grass takes place to bind together the loose powdery soil and prevent its erosion. From Nyasaland (3), there comes definite historical evidence of the rapidity with which the face of the country has been changed. *Within the memory of living men* wide tracts have been denuded of their forest canopy, with consequent cessation of the streams, and in some cases complete abandonment of farming operations. Basutoland (4) and Rhodesia (5) tell the same story.

Equal emphasis must be given to the evils of shifting cultivation. Professor Ogilvie (6) has recently summarized the situation in N. Rhodesia, from information given in the answers to a questionnaire which he sent out to a number of district officers there. He points out that the essential feature of local agriculture implies pollarding or felling the trees, and the application of the ash derived from burning the wood to the gardens, the taking of one or two crops, followed by natural regeneration for a term of years. The exact period required for this is variously estimated, but what is certain is that the period is steadily being reduced, owing to the rapidly increasing population and that it is totally illogical to expect Nature to stand up to such treatment, even though as he says, "The average administrative officer and indeed also many of the agricultural staff have a sublime and touching faith in the power of Nature to reproduce an equally good crop of jungle after each rotation of 'bush fallowing' as occurred originally". The trouble is aggravated by this reduction of the interval between fellings, for the cultivator must perforce destroy more acres of forest to obtain what he wants, or else be content with a smaller return.

The first remedy is to see whether any form of fixed agriculture can be found to take the place of such shifting and apparently wasteful cultivation. Much depends on the fertility of the land and it is probable that in large areas in tropical Africa this is of a poor standard. Stent for instance shows (7) how

1. Stockdale, F. A.—"Soil Erosion". *Empire Cotton Growing Review*, XII, p. 1.
2. *Final Report of the Drought Commission*.—Union of South Africa. Government Printer, Pretoria.
3. Hornby, A. J. W.—*Dept. of Agric. Bull.* 11 (New Series). Government Printer, Zomba, Nyasaland.
4. Pim, Sir Alan.—*United Empire*, XXV, p. 266.
5. "The dangers of soil erosion and methods of prevention". *Rhodesian Agric. J.*, XXXII, p. 533.
6. Ogilvie, A. G.—"The Native and his industries in Northern Rhodesia." British Association Meeting, 1934. *Nature*, 20th October, 1934.
7. Stent, H. B.—"Observations on the fertilizer effect of wood burning in the 'chitamene' system." *Ann. Bull. Dept. Agric., N. Rhodesia*, 1933. p. 48.

effectively the 'chitamene' practice in Nyasaland of burning large quantities of branches of trees in the gardens before sowing *Eleusine coracana* increases the potash and phosphoric acid status and improves the physical condition of an otherwise moderately fertile soil.

Faulkner in Nigeria has, however, blazed the trail of 'mixed farming' and has successfully shown how by *keeping stock*, the fertility of the land may be maintained, and an extension of this practice may be anticipated. But the change-over will be slow and the matter will not bear delay. It must be realised at once by everyone concerned that after land has been cleared for cultivation, it must be allowed a sufficient period of time for regeneration and on no account must it be cleared again until this is complete. There are various ways in which regeneration can be assisted, such as by protection from fire, or by sowing some form of cover* before the area is finally abandoned, but the idea must never be lost sight of that the whole fabric of primitive agriculture is built up on revegetation by the natural plant cover.

When the period required for regeneration in any area has been fixed, it will then be possible to decide on the number of cultivators it will support, and beyond this number the surplus population must be drastically pruned out periodically. Just how this is to be done, by redistribution or diversion to other occupations, is a local administrative problem of considerable difficulty, but done it must be, for the alternative is famine and its attendant miseries.

The land then is the peoples', and if owing to conditions which are the result of their contact with civilisation, namely peace for themselves, and freedom from contagious diseases for their flocks and herds, they are now tending to spoil their own property, civilisation must come to their rescue in their own interests, and educate them in better methods. Meanwhile the government must, for the present, exercise control over, not necessarily own, all such common lands in order that their value may be conserved and placed on a steady yield basis.

R. C. W.

* R. H. Fraser suggests Pigeon Pea, *Cajanus indicus*, as most suitable in N. Rhodesia in these circumstances—(private communication).

COLLECTION AND CLASSIFICATION OF CROP VARIETIES AND RELATED SPECIES.

By E. E. Cheesman.
Imperial College of Tropical Agriculture, Trinidad.

[*Communicated by Dr. F. J. Pound*, Ph.D., *to the Imperial Botanical Conference held in London, August*, 1935.]

Among the numerous functions of botany in relation to tropical agriculture, none can be held more important at the present stage of development than the provision to the agriculturist of genetically better planting material. The ground to be covered in this respect before conditions approach those obtaining in temperate crop production is scarcely realised except by botanists in close touch with the crops concerned. Anything that will tend to accelerate the closing of the gap is of vital importance, and an aspect of the matter which I am glad to find this conference considering is the organization of studies in crop taxonomy.

Other botanists will probably tell the Conference something of what has been done in this direction in temperate countries. This contribution may rather reveal what has *not* been done in the Tropics, but a useful purpose may be served either if suggestions are forthcoming for improvement or if attention can be drawn to the real need for bigger botanical staffs and more exploration as the only true solutions.

Every plant breeder knows that an adequate variety collection is a prime essential for his work. Very few are in possession of a collection nearly as full as they could wish, and the drawbacks of incompletely representative collections are not peculiar to the Tropics. The difficulties are, however, aggravated there, by the virtual absence of any trade organizations for plant exchange, by relative difficulty of communications, and above all by the lack of systematic information. By way of illustration may be cited the present position of botanical researches on two very different crops, bananas and cacao. Bananas are regularly propagated vegetatively, and hence varieties are clonal, a simpler state of affairs than most. There are, however, thousands of varietal names, and little information on synonymy, so that nobody knows even approximately how many clones are extant. A breeding programme rendered necessary a survey of varieties, and we have been engaged on it for some ten years, with the invaluable co-operation of Kew. From our observations certain conclusions emerge, of which the first is that classification is out of the question until much more has been done in identification and in determination of the total range of variability. The second is that identification and establishment of synonymy can only be done by the most careful comparisons of *living* material. This means that if accurate identifications are to be made at least one type collection of living plants must be maintained, and it is important to notice that the whole object of a type collection fails unless it is kept under the strictest botanical

control, by a responsible officer who knows his varieties. Many instances could be cited of confusion caused by accidental shifting of labels in ordinary collections, and the consequences of a similar error uncorrected in a type collection are too horrible to contemplate.

I believe that the principle of living type collections must ultimately be officially adopted for a large number of crops and the fact must be faced that they are relatively expensive to maintain properly, partly on account of the area of land permanently occupied, but more on account of the standard of supervision required. That the expenditure will prove profitable is illustrated by a case in which three alleged varieties of bananas were all the subjects of independent researches in storage and transport until, brought together at the Imperial College of Tropical Agriculture, they proved to be the same variety under three different names. That information available a few years earlier would have saved many pounds.

The only hope of reducing to order the chaos prevailing in this particular crop appears to lie in a combination of local and centralised action under one organization. The chief factor limiting the rate at which comparisons can be made on a central station is the slowness of introductions, due to restrictions imposed by very necessary quarantine measures. Even within countries much confusion of nomenclature exists, and the first step is obviously for each country or administrative unit to determine local synonyms and reduce to a minimum the number of varieties that have to be submitted to the central station for comparison. This process is long and laborious, but it is straightforward and it is under way.

There is, however, another aspect of the banana problem altogether. Genetical researches show that the existing varieties, mostly highly sterile, are in the main triploid plants which have probably been derived from diploid species. To the plant breeder they are useless until he has the appropriate diploid species to combine with them, and the wild species of *Musa* are as yet almost uninvestigated. About a score of *Eumusa* species have been described, of which not more than half a dozen are readily obtainable. In our studies we have been greatly helped by the generous assistance of botanists and others in several countries and have succeeded in establishing to date ten species. Of these at least four appear to be hitherto undescribed. Such a proportion indicates a strong probability that many more remain to be discovered.

The relevant section of the genus *Musa* ranges from the Himalayas through Burma, Siam, Indo-China, Malaya and the East Indian Archipelago down into the South Seas, and the difficulties of collecting viable planting material in the remoter parts of these countries and islands can be imagined. Nevertheless, the possibility has to be faced that whilst we are doing what we can with the material available to solve an important economic problem, the key we seek may well be lying unknown in the middle of Indo-China.

Few clearer examples of the economic significance of more intensive botanical exploration could, I think, be found, but if we turn to a totally different crop we shall find a similar state of affairs.

Cacao is a crop regularly propagated by seed, and as grown in Trinidad and elsewhere exhibits the features of a hybrid population derived from more than one species of *Theobroma*. The unit for genetical study is the individual genotype, and the term " variety " has no precise meaning until clones are established. The most pressing problems are those of selection and propagation of the best individuals in the mixture, and much has been accomplished along those lines during the last five years. Yet in selection from any one population, even if it be as heterogeneous as that of Trinidad, there can never be any confidence that the full range of potentiality is being exploited.

The most fundamental botanical researches needed on cacao, as distinct from those calculated to give the quickest substantial economic returns, are those concerned with the origins of the crop. Our ignorance of the total range of variation occurring is little short of amazing when the importance of cacao in the world's markets is taken into account. Nowhere, to the best of our knowledge, is there even a passably good collection of the tree types of all countries. The wild species of *Theobroma* are even less known in the living state than those of *Musa*, and even of those that have actually contributed to the constitution of commercial cacaos our knowledge is of the vaguest. We can see evidence of the blending of white-seeded and purple-seeded species, and the whole series has been interpreted as derived from two extreme forms. It is, however, very doubtful if this represents a true picture. Almost certainly at least two white-seeded species and probably two or more purple-seeded species have been involved, and it is very necessary that they be defined. It is among them, or perhaps among other species which will hybridize with the complex though not at present part of it, that resistance to pests and diseases, increased hardiness, and factors enhancing specific components of quality are to be sought.

The region to be searched in this case stretches from Mexico to Peru, and includes the Amazon and Orinoco basins. It is no less formidable than the Eastern distribution of *Musa*, but in both cases the practical impossibility of "combing" the whole area is no argument against exploration on any scale that is practicable in selected districts.

I will not take up the time of the Conference with any further illustrations of a need that will be admitted by all. My excuse for the time already occupied must be the magnitude and monetary importance of the problems confronting us in tropical crop improvement. They are so obviously beyond the individual, or even the single institution, that they can only be discussed with any possibility of profit on an Imperial basis, and therefore most appropriately by an Imperial Botanical Conference.

PROBLEMS CONNECTED WITH ROOT DISEASE OF SUGAR-CANE IN ANTIGUA.

By H. R. Briton-Jones.

[*At the request of Government the writer recently visited the island of Antigua to report on the present position in regard to Root Disease of sugar-cane. The visit extended over a period of four days during which time a survey of Root Disease was made on the several varieties of sugar-cane on the variable types of soil all over the Island.*]

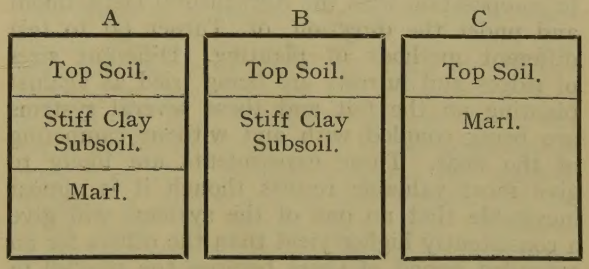
Several fungi have been associated with root disease of sugar-cane in Antigua but the most common species found by the writer was *Marasmius sacchari*. No microscopical or cultural work was done so that it is not known whether fungi like species of *Pythium* and *Rhizoctonia* play their part in the disease complex or not. And from the practical point of view it does not very much matter. Indeed the writer wishes at the outset to avoid complicating the important issues to planters by introducing the Latin names of organisms whose activities are dependent on the lowering of the vitality of the sugar-cane plants by adverse soil, weather and other conditions. In order to clear one point concerning which there has been some doubt it is perhaps advisable to mention that the so-called red leaf-sheath disease of the variety Ba. 11569 in Antigua is just an advanced stage of root disease of the Marasmius type and is not caused by *Sclerotium Rolphsii*. On the other hand, this latter fungus was observed attacking the leaf-sheaths of closely planted B.H. 10(12) and killing tissues at the nodes including roots and buds. With that the fungus *S. Rolphsii* can also be eliminated from the planters' minds because the distance of planting of any variety of sugar-cane in Antigua should be based on final yield figures and not on the presence or absence of a fungus or fungi on the roots, stems or leaves.

The leaves of the variety Ba.11569 are generally mildly attacked by Gummosis (*B.vasculorum*) and under conditions of high winds in wet weather the disease is apt to affect the leaves more or less seriously. Some few years ago there was some discussion as to the advisability of introducing legislation forbidding the growing of Ba. 11569 in several West Indian Islands. This was a point of view with which the writer could not agree and, therefore, advised that Ba. 11569 should be retained until such time as a more suitable variety could be found to replace it for reasons other than that the new variety might be immune to Gummosis. It is interesting to note that Gummosis was also found attacking the leaves of B. 2935 though to a milder extent than Ba. 11569 possibly because the spines on the margins of the leaf are not so long and sharp as those in Ba. 11569. The variety B.H. 10(12) is also attacked to a mild extent and though this disease is never likely to be serious on this variety it is as well to bear in mind that it might function as a carrier to other more susceptible varieties in other countries. At this point the writer deliberately dismisses from discussion the various fungi and the bacterial Gummosis since he is convinced that they are of no practical importance in Antigua and that the future policy in regard to the sugar-cane industry in that Colony should in no way be influenced by their presence. The writer examined sugar-cane fields for root disease in all parts of Antigua and, with the exception of one estate, the malady was found in every ratoon crop examined and in the majority of the plant canes.

The variation in the types of soils is enormous and has been the subject of a survey by Hardy, McDonald, and Rodriguez (2). The discussion of these soils herein is given in general terms and confined to the main issues as they affect the soil moisture question and its relation to root disease. The reader is referred to the publication by Hardy, McDonald and Rodriguez for a more detailed and technical account of the soils of Antigua.

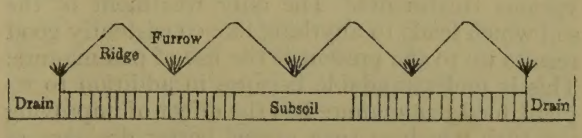
Text figure 1 gives a diagrammatic representation of the three main soil profiles in Antigua as found by the writer. There are, of course, several intermediate types and the depths of each layer varies tremendously even within the same field of sugar-cane.

Figure 1.



Text figure 2 shows the system of land preparation and planting which, with some variation in the height and width of the ridges, is almost universally used in Antigua. The only

Figure 2.



other difference recorded was the fact that unlike that shown in this cross-section of the cane bed the ridges sometimes run across and not longitudinally on the beds.

It will be seen from text figure 2 that the sugar-cane is planted in the furrow and this has been necessary in order to get down to soil which is sufficiently moist to induce germination and moreover the attempt has been made to make the maximum use of subsequent light showers. The rainfall in Antigua is extremely variable particularly in its distribution. Prolonged periods of dry weather are the general rule in the dry season but they also occur to a lesser though significant extent in the wet season; moreover, heavy showers fall at irregular intervals in the wet season. The result is that the soil becomes either too dry or too wet for the satisfactory growth of the sugar-cane and under such conditions root disease develops. Yields are, therefore, very uncertain and a field of plant cane may suffer badly from root disease and give a poor yield but quite a satisfactory yield later as a first and/or second ratoon. Field observations show that a change in weather brings about recovery or death of sugar-cane previously affected by root disease in the same growing season.

On the majority of the estates ploughing and other tillage operations have been done by cattle and hand labour. This is of such a high standard that weeds in cane fields are the exception rather than the rule and with the implements used every effort has been made to drain the top soil moisture in the wetter districts and to conserve it in the drier. Owing to the extreme variation in the distribution of the rainfall at different times of the year in what are looked upon as the wet and dry localities either one of the foregoing operations may be successful or lead to failure.

Experiments are now being carried out by the Sugar Cane Investigation Committee of Antigua in co-operation with the Agricultural Department and under the direction of Turner (3) to test different methods of planting. Different sizes of ridges and furrows are being tried as against planting on the flat and these several systems are being coupled with and without cambering of the beds. These experiments are likely to give most valuable results though it is almost inevitable that no one of the systems will give a consistently higher yield than the others for an extended period of years because the rainfall in one year will suit one form of lay-out and fail in another year on the same land or even in the same year on another type of soil. These two variants are apt to upset the most carefully laid plans which become even more complicated when testing different varieties of sugar-cane under the various treatments. The only treatment of the soil which leads to anything like consistently good results up to the present is the use of pen manure. This is understandable because in addition to its plant food pen manure has the effect of improving the tilth which in turn means better drainage of the top soil coupled with its increased capacity for the retention of soil moisture. In other words it tends under conditions of fluctuating rainfall, to flatten out the soil moisture curve. On the other hand, there is a limit to the amount of pen manure produced and though very valuable where it can be economically applied to the land the writer's recommendations herein anticipate a decrease in the amount of pen manure produced in the future.

It will be noted that the foregoing remarks apply to the method of soil preparation now in vogue on the majority of estates in Antigua. And attention is drawn to the fact that the subsoil remains completely undisturbed on the cane beds from year to year. This has also been commented upon by Box, Collens and Warneford(1). The depth of ploughing given is about six inches. There are two reasons for this, namely, that the soils are in the main heavy work for cattle and secondly there is a general timidity about disturbing the sticky clays which compose the subsoil and which are said by some to be agriculturally unchangeable.

In addition to the experiments which are now being carried out under the direction of Turner (3) on soil tillage, drainage, fertiliser and variety trials the writer would stress the necessity for preliminary trials on a small scale with subsoil drainage. With shallow topsoil overlying impervious stiff clay or marl the possibilities of drainage coupled with retention of soil moisture in the surface soil is limited unless some form of operation is conceived which will concurrently improve the subsoil drainage and thus induce a deeper root system. Before making various suggestions with a view to accomplishing efficient subsoil drainage in Antigua the writer would stress two points, namely (*i*) that trials should be carried out on a small scale in the first place before large sums are expended on the motor-driven implements necessary for their application on a commercial scale and (*ii*) that no one of the suggested methods is ever likely to give the optimum results on all the types of soil under sugar-cane in Antigua.

The soil profile shown in text figure 1 A shows that between the top soil and the underlying free-draining marl is a layer of stiff impervious clay so that in this case the source of the trouble is the latter. The top soil may be but a few inches deep or may be several inches in depth and the same variation applies to the layer of stiff clay and marl. In all cases however motor-driven tractors and ploughs will be necessary for the work on a large scale.

Suggested experiments for subsoil drainage of the type of soil in text figure 1 A and B are :—

(I).—Plough to the full depth of the top soil.

(II).—The plough to be followed by knifing as deeply as possible across the beds. In a number of cases the knives will cleave through the stiff clay and also a few inches of the marl. In others they will not reach the marl, but by gradually increasing the depth of ploughing even to include some of the stiff clay the depth of cultivation can be increased in each subsequent preparation of the land at the time of planting. There is

probably a limit to the depth of ploughing on account of the peculiar properties of the subsoil but if done on a small scale first to different depths this limit can be decided upon.

(III).—Prior to replanting there is in Antigua, owing to its low rainfall, much undecomposed cane trash on the land, and therefore, the following experiment is suggested. After ploughing to the full depth of the topsoil, and banking in the usual way, the stiff underlying clay could then be dug out to a depth of at least a foot and the cane trash buried lengthwise but across the beds. The cultivated clay and the topsoil mixture should then be replaced on the cane trash and the topsoil placed on the top of the latter. This should be done early before planting, which is possible in Antigua, so that subsequent rain will compact the soil sufficient to retain moisture in spite of the subsoil drains composed of cane trash.

(IV).—Bamboo subsoil drains across sugar-cane beds have been tried in British Guiana and there is no reason to believe that this system might not give good results in Antigua. It is at least worthy of trial on a small scale. More bamboos can be grown in the Island to meet increased demand.

(V).—The Gyrotiller now in use on one group of estates may prove a useful implement on the soil types in text figure 1 A and B though care should be taken thoroughly to test its effect first on a small scale where the marl is near the surface.

(VI).—A Gyrotiller is likely to do damage on many of the soil types C because the marl, which is often near the surface, would be churned up with the topsoil and cause a chlorotic appearance of the sugar-cane subsequently grown on it. With this latter type of soil deep knifing and subsoil drains are therefore likely to lead to better results.

(VII).—The foregoing suggestions might be tried using the same banking system in use at the present time as well as planting on land levelled subsequent to the knifing, burying of trash, or bamboo subsoil draining.

(VIII).—After ploughing and knifing a grader might be found effective in improving drainage since it could be utilised to shave off the topsoil and part of the subsoil in forming the main surface drains.

(IX).—The shaving of stools after harvesting might be tried as a subsidiary factor.

(X).—Box has pointed out that the white sugar-cane grub (*Lachnosterna antiguensis*) is more prevalent on badly drained land, and the writer's observation that these grubs are more numerous at the roots of sugar-cane suffering badly from root disease gives support to Box's conclusion. The aigrette type of bird known in Antigua as the Galding is recognised as being useful to the agricultural community because it is insectivorous. There are quite a number of these birds in the Island just as there are in British Guiana and the writer wonders why an effort has not been made to breed these birds in an aviary. The young reared in the aviary could be allowed full freedom and would probably return at night after foraging during the day. These birds have their natural enemies and the added protection of the aviary would probably mean a rapid increase in numbers. The method has been used with marked success at Giza in Egypt whence the birds fly in large numbers over the Delta, follow the plough and feed on grubs, and return to roost in the evening. Subsequent to the feeding and housing of the first captive pairs of birds the expense would be small.

With the present system of sugar-cane growing in Antigua at least 75 per cent. of the top soil is not utilised by the crop because but a small percentage of the sugar-cane roots grow into the ridges. The importance of this fact has also been appreciated by others including Box and Turner and the latter is at present investigating the possibility of planting on the level or in shallow ridges.

An additional factor of importance which has occurred to the writer is the insolation to which the young cane is exposed in the dry season when grown between ridges the soil of which has been exposed week after week to a tropical sun. Jenny's Law in regard to the influence of soil temperatures on the rate of loss of humus in tropical soils certainly operates under the conditions in Antigua. It is suggested that an attempt be made to obviate the deleterious effect of bright sunshine in dry weather on both the soil and sugar-cane by growing protective crops on the ridges. These could be established before the sugar-cane sets are planted. Moreover the crops tried might be of two kinds, namely, those which merely give ground cover and those which are bush-like and would serve as shade for the soil and young sugar-cane as well as function as a windbreak. It is difficult to suggest one of the former class of crops because in Antigua leguminous cover crops like *Canavalia ensiformis* are regularly stripped of their leaves by insect pests. Of the latter class the pigeon pea and *Crotalaria anagyroides* might be tried. The trash from these might be subsequently buried for subsoil drainage. Both could be planted early enough to ensure a good supply of seed for subsequent use.

The writer would repeat that the foregoing are suggestions for trial on a small scale in the first place and that he definitely avoids making claims for the success of any of them. On the other hand, past experience in Antigua has shown that with the best attention given only to top soil drainage the results have been disappointing. A radical change of policy is, therefore, necessary but the direction which this should take should be based on the results of experiments which must be repeated for at least six years in order to strike the best possible mean for the variable conditions of rainfall. Bold expression of opinion based on published literature and applied to conditions in Antigua is dangerous.

Work is now being carried out on all estates to determine the most suitable varieties of sugar-cane to grow on the lands and whilst this is most important it is as well to bear in mind that when the best means of subsoil drainage has been determined for each field on the several estates and whether the drainage system works better with furrow or flat land planting the question of selection of varieties will again be reopened and the best varieties in some places under the present system of agriculture may be supplanted by another variety already in the Island or one imported from outside.

Small observation plots in which several of the above suggestions are being put into operation are now being laid down by the Agricultural Superintendent at the Experiment Station. It is hoped that these will serve as pointers for larger field experiments.

Acknowledgment.

I would take this opportunity of thanking all those agriculturists, with whom I came in contact during my visit to Antigua, for their generous discussion of local conditions and their several difficulties. In this connection I specially wish to thank Mr. F. H. S. Warneford, Agricultural Superintendent, who did everything he possibly could by showing me the sugar-cane crops on different types of soil and giving unstintingly of his knowledge based on many years experience of local conditions.

References.

(1) Box, H. E., Collens, A. E. and Warneford, F. H. S. —Observations on sugar-cane cultivation in Antigua. St. John's, Antigua, 1931.
(2) Hardy, F., McDonald, J. A. and Rodriguez, G.— The Sugar Cane Soils of Antigua. April, 1933.
(3) Turner, P. E.—A critical review of agricultural practices on sugar estates in Antigua, with special reference to a scheme of field experiments.

SOME WORM PARASITES OF STOCK IN ST. LUCIA.

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Introductory.

Comparatively little work has been done on the internal parasites of domestic animals of the Lesser Antilles and even less has been published. Cameron* published a list of parasites, mostly collected by himself, found in stock between St. Kitts and Trinidad, but he had no opportunity of examining any animals in St. Lucia.

In June 1934, I paid a short visit to that island and collected a number of helminths from sheep, cattle and pigs. These were identified while on study leave at the Institute of Parasitology, McGill University, Macdonald College, P.Q., Canada, and I am indebted to the staff of the Institute for their assistance.

Trematoda.

Fasciola hepatica.

This common liver fluke of sheep was found in the liver of a pig and a cow. It has not previously been recorded from these hosts in the West Indies.

Paramphistomum cotylophorum.

Considerable numbers of this parasite were recovered from a sheep from Vigie. This species has been recorded from the Greater Antilles and is probably the one referred to by Cameron as *Paramphistomum* sp. It has not previously been recorded from the Lesser Antilles.

* Cameron, T. W. M.—"Helminth parasites of stock in the British West Indies". *Journal of Helminthology*, Vol. VIII, No. 2. Reproduced in *Tropical Agriculture*, Vol. VIII, No. 2, pp. 30-32 (1931).

Nematoda.

Haemonchus contortus.

This stomach worm, which is one of the most serious parasites of sheep and cattle, was found on three occasions on the Island and, contrary to Cameron's experience in other islands, it was present in considerable numbers.

Ostertagia circumcincta.

This parasite was found in one sheep from Cap, but was present in small numbers.

Trichostrongylus instabilis.

This parasite was found in two sheep (Cap and Vigie) in large numbers. A few specimens of the related *T. extenuatus* were also present. This latter species does not appear to have been previously recorded from the British West Indies.

Oesophagostomum columbianum.

This parasite was recovered in considerable numbers from the colon and caecum of a sheep from Vigie. Nodules were present on the intestinal wall. I have also found heavy infections with this parasite in the Island of Carriacou in the Grenadines.

Setaria labiato-papillosa.

A single example of this worm was found on the outside of the liver of a cow. Cameron saw this species only in Trinidad.

Metastrongylus elongatus.

This parasite was seen in the bronchi of a pig.

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

St. Kitts.

After making a record crop of 28,491 tons of sugar during 1935 reports indicate that owing to insufficient rain in certain districts of the island the 1936 sugar crop is likely to be a good deal shorter.

The work of the Sugar Cane Investigation Committee, working in co-operation with the Agricultural Department and directed by Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture, is making very satisfactory progress. The numerous experiments laid down by the Committee were reaped during the 1935 crop season and the results have recently been published in the Annual Report of the St. Kitts Agricultural Department and will be presented to the Committee by Mr. Turner in due course.

The question of the relationship between the planters and the only sugar factory in the Island was recently the subject of an enquiry conducted by Mr. C. Y. Shephard, Professor of Economics at the Imperial College of Tropical Agriculture. The interests concerned await the outcome of this enquiry with a great deal of confidence and it is anticipated that one of the results will be the adoption of a policy of closer co-operation between the two branches of the industry. If an agreement is arrived at between the two parties it is anticipated that the work of the Sugar Cane Investigation Committee will be extended to include experiments of a much wider range than has, under present conditions, been possible. Such problems as the mechanical transport of the cane and the introduction of tractors for cultivation purposes will receive special attention.

The Sea Island cotton crop in St. Kitts during 1935 was small in area but satisfactory yields were obtained. During the last two years two types of cotton have been grown on the island, the tendency at present being to extend the Montserrat type of cotton which is rather shorter and less fine than the St. Kitts strain. Both types have this year sold readily but there was an inclination on the part of the buyers to cut down the premium which the St. Kitts strain usually commands. It is anticipated that a larger area will be planted during 1936 if this is recommended by the West Indian Sea Island Cotton Association of which body the St. Kitts planters are keen supporters.

* * *

Nevis.

This island has suffered from a severe and prolonged drought which fortunately broke in September. The rain came too late to improve materially the prospects for the 1936 sugar-cane crop but it was in time to enable a large area to be planted in Sea Island cotton. Final figures are not yet available but it is estimated that close on 2,000 acres have been planted in this crop. The cotton production of 1934-35 has been disposed of at such a figure as will enable the Government owned ginnery to pay a price of 7.7 cents per lb. for seed cotton.

The new land settlement scheme established at Hamiltons is progressing satisfactorily. A block of land on the estate which was not originally surveyed has been applied for by a number of prospective settlers and its survey is now being proceeded with. Practically all the lots on this estate have found ready purchasers. The main crops grown are sugar-cane, cotton, tomatoes and ground provisions.

* * *

Antigua.

Owing to the dry weather experienced in the earlier months of the year the prospects for the 1936 sugar crop are not encouraging. Good rains were however experienced during October and November. As in the case of St. Kitts, the Sugar Cane Investigation Committee of Antigua has conducted a most comprehensive series of experiments some of the results of which are published in this issue.

A mycological survey of the sugar-cane area of the island was recently undertaken by Dr. H. R. Briton-Jones, Professor of Mycology at the Imperial College of Tropical Agriculture. His report has been received and is published in this Journal in the form of an article. The most prevalent disease of sugar-cane attacking the root system is *Marasmius sacchari*. Gumming disease was also found on several varieties including the new Barbados cane B.2935. The author, however "deliberately dismisses from discussion the various fungi and the bacterial Gummosis since he is convinced that they are of no practical importance in Antigua and that the future policy in regard to the sugar-cane industry in that Colony should in no way be influenced by their presence". With reference to the control of the root disease, suggestions are made for the improvement of the soil conditions by more thorough tillage and more adequate drainage. The importation of the gyrotiller to the island a few years ago and the more recent importation of three tractors should ensure the more thorough cultivation of the soil provided the implements used are intelligently selected and are modified to suit the varying soil conditions. Dr. Briton-Jones' report has been submitted to the Sugar Cane Investigation Committee who will no doubt give it careful consideration and institute trials of the various suggestions made.

The Entomologist attached to the Imperial College has paid three visits to the island during the last few months and on each occasion has taken with him a consignment of Amazon flies.

These flies have been liberated in selected localities and it is hoped that they will become established as effective parasites on the small sugar-cane moth borer.

The acreage in Sea Island cotton for the 1936 reaping has been extended to about 600 acres which is a great deal more than has been planted in Antigua during the last few years. The Montserrat strain of cotton is now cultivated in Antigua. The cotton produced during 1935 was favourably reported on and met with a ready sale. By arrangement with the Agricultural Department of Montserrat pedigree seed is imported each year and is bulked up under the supervision of the Antigua Department of Agriculture. There are considerable areas in the Colony well suited to the cultivation of cotton which should become a major crop, especially for the peasant class. The Antigua Cotton Growers' Association and the owners of the Cotton Ginnery are organisations set up many years ago to further the interests of the industry. They meet at frequent intervals and are members of the West Indian Sea Island Cotton Association.

Three land settlement schemes have been inaugurated in Antigua by the Government and there is need for further development in this direction. Numerous peasants have thus been given the opportunity of becoming owners of small parcels of land. The agricultural development of these schemes has been entrusted to the care of the staff of the Agricultural Department.

* * *

Montserrat.

It is with great regret that we have to refer to the unfortunate recurrence of severe earthquakes in this island. Many estate houses and buildings have been severely damaged but fortunately no lives were lost.

The 1935 cotton crop has been a record one and over 900,000 lb. of clean lint has been produced. Keen competition prevailed in the island for the seed cotton and lint and good prices were paid. Most of the cotton was sold before it was exported and it is evident that even larger quantities could have been disposed of. The late planted cotton suffered severely from the ravages of the pink boll-worm.

The agricultural officer reports that the prospects for the further extension of the tomato industry are good. The experimental stage has been passed and the best marketing period is now known. After many years of research and trial it is now established that the only profitable market for tomatoes in Canada is that available between the months of March and June. Fortunately there are considerable areas in Montserrat capable of giving good crops of tomatoes and other vegetables during that period of the year.

* * *

Dominica.

Judging from the latest available figures the exports of citrus fruit particularly of grapefruit from Dominica have increased during 1935. Exports of bananas continue to increase and by the end of the year will be more than double the quantity shipped in 1934. Were the shipping facilities from this Island to the United Kingdom more frequent the possibility of developing the green lime trade with the mother country, in view of the sanctions imposed on Italy would no doubt receive the serious consideration of exporters.

Recently an Agricultural Advisory Committee has been set up by Statute to be presided over by the Administrator. This brings the island into line with several other West Indian Colonies in this respect. Much useful work awaits this organisation and it will afford Government and planters an opportunity of consulting on matters of agricultural policy.

* * *

St. Lucia.

The prospects for the 1936 sugar crop are said to be good. The canes have made good growth throughout the wet season. The entomologist reports that he has recovered the Amazon fly in satisfactory numbers in all the areas where it has been liberated. By the end of the year it was expected that the fly would be established on all the important sugar estates in the island.

The lime crop is definitely short this year and whilst the green lime exports have been maintained as compared with 1934 the production of lime oil is expected to show a considerable falling off. The organization set up for the marketing of lime oil is making satisfactory progress. One of the Directors of the Trinidad Lime Oil Company who is also a Director of the West Indian Lime Oil Sales Company recently paid a brief visit to St. Lucia and met one of the large New York buyers who was on a visit to that island. The consultations thus made possible were most opportune.

The banana exports of the island continue to expand and favourable reports as to quality continue to be received. The development of the Murray road area awaits the formulating of plans by the Public Works Department. Up to the end of November the total exports for the year amounted to 52,903 bunches.

The planting community of St. Lucia will regret the departure of Mr. A. F. Nichols, the Agricultural Superintendent who has been promoted to the post of Assistant Director of Agriculture in the Seychelles. Mr. Nichols was appointed to St. Lucia in 1931 and has done excellent work during the 4½ years which he served in the island.

* * *

St. Vincent.

Owing to civil disturbances the General Meeting of the West Indian Sea Island Cotton Association which was to have been held in St. Vincent in November, has been postponed to the first week in January. All Island Associations have nominated delegates. The area planted in Sea Island cotton in St. Vincent this year is estimated to be over 3,000 acres which is far in excess of the acreage planted during the last four years. The

stand has been excellent and the prospects for a good crop are promising. At no time in the history of the industry has such a large area been planted in extra superfine Sea Island cotton. From the information available the greatest demand appears to be for the shorter strains of Sea Island rather than for the extra superfine which was in demand in the past for the making of lace material. It remains to be seen whether planters in St. Vincent have not over-estimated the demand for their very special high quality cotton.

The production of arrowroot during 1935, exceeded all past records and serious consideration must now be given to the question of controlling production to keep it in line with the world demand for this product. Exports during the year have amounted to 25,700 barrels whereas production was in excess of this. A few years ago exports were down to 17,000 barrels but with the formation of the Co-operative Arrowroot Association in 1931 a demand has been created which absorbs over 25,000 barrels annually.

Up to the end of October close on three million coconuts were exported which is eight times the quantity shipped in 1934. The prospects for copra have improved considerably during the last few months.

Sale of syrup or fancy molasses produced in St. Vincent has been slow and disappointing, owing probably to excessive production in Barbados. In an effort to improve the quality of the product a loan has been made by the Colonial Development Fund Committee to enable a crop specialist to be employed. It is hoped that as a result of this appointment a better and more uniform grade of syrup will be produced in future.

* * *

Brevities.

Mr. C. C. Skeete, Assistant Commissioner, visited Dominica and St. Lucia in November and December, 1935.

Mr. L. de Verteuil, Assistant Agricultural Superintendent, Antigua, was granted leave of absence in December, 1935.

Mr. C. K. Robinson, Agricultural Officer in St. Vincent, who spent his vacation in Trinidad, returned to St. Vincent on 30th October.

Mr. H. E. Box, Entomologist attached to the Advisory Department, left St. Lucia for Antigua on 30th November and returned on 12th December.

Mr. G. A. Jones, Commissioner of Agriculture, visited the Islands of Antigua, Montserrat, St. Kitts and Nevis in October returning to Trinidad on 6th November.

Mr. A. F. Nichols, Assistant Agricultural Superintendent of St. Lucia, has been promoted Assistant Director of Agriculture, Seychelles. Mr. Nichols left St. Lucia on 2nd December, 1935.

Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture, left Trinidad on 18th November, and returned on 18th December.

Dr. H. R. Briton-Jones, Professor of Mycology, Imperial College of Tropical Agriculture, visited Antigua in November, leaving Trinidad by air on 18th November and returning on the 23rd.

Arrangements have been made for Mr. S. A. Schouten, Agricultural Assistant, Montserrat, to spend four weeks at the Experiment Station in St. Vincent studying cotton breeding methods under the direction of the Cotton Research Officer, Mr. S. H. Evelyn.

Mr. C. C. Seale, Dip. Agric. (I.C.T.A.), has been appointed a crop specialist in connection with the syrup industry of St. Vincent. Prior to taking up his appointment Mr. Seale spent some time at the Sugar Technology Department of the College. He arrived in St. Vincent on 30th October.

At the Annual Stock Sale of the Trinidad Government Farm held on 30th November, purchases of stock were made on behalf of a planter in St. Vincent. The St. Lucia Government has recently completed several purchases to add to its stock of well bred animals.

COFFEE CONSUMPTION.

The following figures giving the consumption of coffee in the years 1924 and 1933 in pounds per head of the population in twenty countries may be of interest. They have been calculated from figures supplied by the Brazil National Coffee Department and show the ten-year changes. It will be seen that coffee drinking per head of population during the past ten years has only increased in seven out of the twenty countries below :—

Country.	Lb. per capita.	
	1924	1933
Sweden	15.8 lb.	16.2 lb.
Holland	11.8 do.	14.5 do.
U.S.A.	11.2 do.	12.7 do.
Belgium	11.0 do.	9.8 do.
France	10.6 do.	9.7 do.
Switzerland	8.3 do.	6.4 do.
Algeria	3.3 do.	4.6 do.
Germany	1.9 do.	4.5 do.
Argentine	5.7 do.	4.5 do.
South Africa	4.2 do.	3.4 do.
Canada	2.4 do.	3.1 do.
Italy	2.6 do.	2.0 do.
Spain	2.1 do.	2.0 do.
Austria	2.6 do.	1.8 do.
Egypt	1.7 do.	1.1 do.
United Kingdom ..	0.7 do.	0.8 do.
Australia	0.5 do.	0.5 do.
New Zealand	0.3 do.	0.2 do.
Japan	0.1 do.	0.1 do.
Persia	0.1 do.	0.1 do.

—(*The Planters' Chronicle*, Vol. XXX, No. 10, p. 269, 1935.)

FURTHER NOTES ON THE FOOD AND HABITS OF TRINIDAD BIRDS WITH SPECIAL REFERENCE TO COMMON CANE FIELD BIRDS.

By D. Vesey-FitzGerald.

INTRODUCTION.

It is now 13 years since the publication of Williams' paper on the food and habits of Trinidad birds, and it seems not out of place to consider the subject again.

The author was fortunate, through the kindness of Mr. Urich, in being able to examine an extensive series of stomachs from birds collected by Mr. H. Radclyffe Roberts in Trinidad during July and August, 1931. To these records have been added a number of stomachs from other sources as well as a few original notes on feeding habits.

The cane lands of Trinidad occupy the low lying country, not exceeding an elevation of 100 feet, at the Western end of the Northern basin, between the Northern and Central Ranges, and a large area of undulating country to the extreme West of the Central Range, not exceeding an elevation of 200 feet. There is no virgin country included in this area but the monotony of the intensive cultivation of the cane fields is broken by areas of waste land, plantations of cacao and coconuts and by two large areas of swamp, Caroni and Oropuche, which though largely altered by drainage schemes and rice cultivation provide suitable nesting sites for a large number of birds.

Smooker (1928) lists 130 birds known to breed in such an area of swamp.

There are many other species more typical of forest or cacao plantations, but for the purpose of this paper a somewhat arbitrary selection of species has been made, composed of birds found in waste land and peasant cultivation, and those swamp birds which are more or less regular visitors to cane fields. In all, some 50 species are considered. A few of these are outstandingly abundant, and it is believed that all the species likely to be of any economic importance to cane cultivation will be found in this list, except the ACCIPITRIDAE and FALCONIDAE, which are not included.

This paper attempts to show that birds in general and certain species in particular are highly beneficial. Any steps taken towards the better preservation and encouragement of desirable birds are therefore, worth considering. The present Ordinance covers all the birds under consideration but how far it is effective is doubtful.

Many small birds are caught on twigs smeared with a bird lime made from the sap of breadfruit, but these are almost entirely the seed eating FRINGILLIDS. The depredation of the mongoose has been considered elsewhere. It appears, with certain exceptions to be considered later, that the chief limiting factor to the bird populations of cane estates is the scarcity of nesting sites. As was indicated above the swamp lands provide ample shelter for many of the most desirable species, but they also provide ample feeding grounds, and little is known about the diurnal and other movements of birds into the cane fields. Shooting during the open season would hardly affect the birds under consideration as they are mostly too small to excite the cupidity of sportsmen. But the rather extensive burning throughout the swamp areas during the dry season may have more serious results. The provision of bamboo bird perches is certainly beneficial since one of the most useful birds, the grey headed keskidee makes full use of these.

The boat tail, *Holoquiscalus*, the Merle corbeau, *Crotophaga*, the scissor-tailed flycatcher, *Muscivora*, three of the most beneficial birds, undoubtedly make extensive diurnal movements into the cane. The latter does not breed in Trinidad, and Williams (1922) has given an interesting account of its migration.

Of the other birds it seems that the most profitable way to encourage them would be the provision of small sanctuaries at convenient places, such as stream sides, pond margins around stock yards and on waste land, throughout the cane estate. An interesting natural sanctuary of this nature was noticed in the heart of one estate, where a growth of black sage, *Cordia;* Immortèlle, *Erythrina glauca;* and other vegetation around a small pond, provided nesting sites for three pairs of white headed widows *Arundinicola*, one pair of grey headed kiskidees, *Tyrannus*, and a pair of red-winged ground doves, *Columbigallina*.

As regards the numbers of birds at present exploiting the cane lands, it may be worth while recording three quarters of an hour observation over a small section of Orange Grove Estate, during September. The birds observed were as follows :—

Twelve grey headed kiskidees (*Tyrannus*),
Twelve Merle corbeau (*Crotophaga*),
Five kiskadees (*Pitangus*),
Three grey ground doves (*Columbigallina*),
Thirteen boat tails (*Holoquiscalus*),
Twenty-five scissor-tail (*Muscivora*),
One cowbird (*Molothrus*),

A number of shortailed swifts (*Chaetura*),
Four yellow legs (*Totanus*),
Two pygmy seed finches (*Sporophila*),
Two green herons (*Butorides*),
A large party of yellow heads (*Agelaius*),
Three palm tanagers (*Thraupis*),
Five Bang's swallows (*Stelgidopteryx*),
Two washer women (*Fluvicola*),
One white headed widow (*Arundinicola*),
Hundreds of barn swallows (*Hirundo*), flying low over a badly blighted field.

This gives, not counting the innumerable swallows, over one hundred potentially useful individuals at work in the fields at about the time of maximum blight. Similar observations on other estates gave comparable results.

The conclusion must be that birds in the cane fields are at present a valuable asset. How this asset can best be developed calls for further detailed consideration of such problems as territory, nesting sites, food, inland movement and the biotic relations of the commoner cane field birds.

FOOD RECORDS AND NOTES.

Family ARDEIDAE (Herons and Bitterns).

Butorides striatus (L).

This is a small black crowned heron, often called "Chuck", frequently seen in rice fields, and about the larger drains throughout cane fields. Its nesting habits and those of a very similar though rarer bird, *B. virescens*, have been recorded by Belcher and Smooker (1934). Six stomachs were examined which showed that a variety of rather large harmful insects were eaten such as mole-crickets, field-crickets, cockroaches, cut-worms, horseflies and grasshoppers. A rather larger proportion of this bird's diet on the other hand consists also of small frogs, *Leptodactylus*; small fish, shrimps, dragonflies and spiders, all of which are more or less beneficial.

Florida caerulea (L).

The little blue heron is a slender bird easily recognised by its blue colour though it is frequently accompanied by its pure white or parti-coloured immature phases. The bird is very abundant on mud flats exposed at low tide but pays frequent visits to the damper cultivated land, especially during the wet season. Breeding habits have been recorded by Belcher and Smooker (1934). From the four stomachs contents examined, its status may be regarded as the same as that of the last species, since large noxious insects such as crickets and moths were taken, but a considerably larger proportion of its diet was found to consist of frogs, *Leptodactylus*; dragonflies and large spiders. The somewhat similar red necked heron, *Hydranassa tricolor* has similar feeding habits.

Family SCOLOPACIDAE. (Snipe and Sandpipers).

Capella delicata (Ord).

Snipe probably of this species are abundant migrants and winter visitors. Large numbers frequent the wetter cultivated areas, and provide good shooting during the winter months. Snipe are mud feeders, and the contents of one stomach examined showed the food to consist of minute insects and algae, with a very large addition of what may be regarded as more or less accidental matter such as grit, mud and broken rice husks. Belcher and Smooker (1935) record the very similar *C. paraguaiae*. Viellot, as a rare resident and the nest from Trinidad.

Actitis macularia (L).

The spotted sandpiper, a common swamp land winter visitor makes frequent visits to the wetter areas of cultivation. It is a general insect feeder, its habits being to run along and catch up small organisms on or close above the ground. By far the favourite food of the 13 birds examined was small crabs, but other Crustacea, small beetles, grasshoppers, fly maggots, beetle larvae and cockroaches had been taken.

Totanus melanoleucus (Gmelin) **and flavipes** (Gmelin).

"Yellow legs" are among the most abundant of the winter visiting waders. Any wet or flooded land is visited. A variety of small insects, beetles, and plant bugs were eaten by both species.

Ereunetes pusillus (L.)

Another common winter visiting sandpiper. All three stomachs examined were packed with grit, but fragments of insects and a few seeds were also found.

Family JACANIDAE (Spurwings).

Jacana jacana.

The Spurwing is a conspicuous and abundant resident on all still waterways. The bird is red-brown with a black neck, and bright yellow primaries which are exposed as the bird flies away uttering its shrill cry. All wetter parts, ponds and drains throughout the estates may be visited. Seven stomach examinations show this bird to be a general insect feeder; ants, grasshoppers, dragonflies, weevils and beetles including the "hard back", *Lygirus* had been taken as well as a few seeds and Diatoms.

Family STRIGIDAE (Owls).

Pulsatrix perspicillata (Latham).

The only stomach of the "spectacled owl" examined contained fur.

Glaucidium brasilianum.

The smallest Trinidad owl appears to be entirely insectivorous, large caterpillars, some exhibiting striking white, black or yellow warning colouration; large moths, large grasshoppers, crickets, and plant bugs, Homoptera, had been eaten by the two birds available, for examination. Williams (1932) records the nest and interesting observations on its food.

Otus choliba.

Another insectivorous owl. One stomach of an adult bird contained a mass of large Orthopterous insects and some remains of a large spider.

Two young birds from a nest in a pigeon coop were hand reared and did well on a diet of butcher's meat and mice. They were particularly fond of large insects, such as cockroaches, mole crickets, green mantids and large hawkmoths. A large insect would be held down with one foot and small bits would be torn off with the beak. This process, however, for some reason was usually rather ineffectual and later the insect would be swallowed whole with comparative ease. When annoyed these birds made a clicking noise with their beaks and when expecting food started hissing.

An adult bird of this species was at one time in the habit of entering rooms at the Imperial College, at night, in order to feed on mole crickets attracted by light.

Family CAPRIMULGIDAE (Nightjars).

The "Nightjars" or "Night hawks" as their name implies are nocturnal feeders. Some species may be seen hawking insects like swifts, but *Nyctidromus albicollis* is commonly seen on the ground catching flying insects by means of short flights. The birds of this family are very retiring. They are, however, common, and being entirely insectivourous must do an inestimable amount of good, as the following records will help to show.

Nyctidromus albicollis (Gmel).

Two stomachs were examined and in both cases harmful beetles had been the favourite food, hard backs, *Cyclocephala* sp., a wood boring longhorn, *Chlorida festiva*; click beetles Elateridae; and beetles of the family Tenebrionidae. But large moths and cockroaches had also been eaten. The nesting habits are recorded in the *Journal of the Trinidad Field Naturalist Club* II 109, 1894.

Podager nacunda (Vieill).

A very varied collection of insects had been eaten by the four birds examined, but flying ants of the genus *Camponotus* predominated. Syrphid flies (beneficial), click beetles, Elateridae; flea beetles, Chrysomelidae; ground beetles, Carabidae; water beetles, Dytiscidae; and plant bugs, Pentatomidae; were also found in most of the stomachs.

Chordeiles acutipennis (Bodd).

The present species is often seen at dusk hunting insects like a swift. Six birds taken from districts Oropuche and Caroni had eaten a very varied assortment of insects as set out in the following summary: dragonflies, Odonata, from five birds in the following proportions: 30 per cent., 60 per cent., 20 per cent., 95 per cent., 80 per cent., Beetles of various sorts, from five birds: 30 per cent., 15 per cent., 20 per cent., five per cent., ten per cent. Plant bugs, Homoptera-Cicadidae ten per cent., and Cixidae five per cent. and "Stink bugs", Pentatomidae, ten per cent. Ants from four birds were in the proportions 20 per cent., five per cent., 35 per cent., five per cent. of the total stomach content, and flies Diptera, of the families Micropezidae and Sapromyzidae 30 per cent. of one stomach.

Family MICROPODIDAE (Swifts).

The various species of swifts are all entirely insectivorous and large mixed parties are frequently seen over blighted cane fields. Any kind of rather small flying insects are suitable for food, and an immense amount of good must be done by these birds. There are eight species recorded from Trinidad, and food notes on the four commonest ones over cane are recorded.

Chaetura brachyura (Jard).

Often known as the "rain bat" this is about the most familiar species of the family. The bird is dark blue, with a conspicuous buff rump and a very short tail. In the single stomach examined the food was almost entirely composed of small bark beetles, but the head of a small wasp and one plant bug, Heteroptera, were also found.

Two stomachs of an allied species *Chaetura cinereiventris* were also examined in which flying ants predominated, but as in the last species "bark beetles" were also in evidence.

Streptoprocne zonaris.

This large black swift, with a conspicuous white collar is frequently seen in large parties, usually flying rather high up. Again flying ants form the bulk of the food in all five stomachs examined. Some small solitary bees, *Halictus* sp. a wasp, *Gymnopolybia*, several Brenthid beetles, Staphylinid beetles and others, had also been taken.

Panyptila cayennensis (Gmel).

The stocking shaped nest of this species has been observed in the grounds of the Imperial College and in Mt. St. Benedict valleys. For a short description see *Bull. Department of Agriculture, Trinidad and Tobago*, VII, 1907, 127. Only one stomach was examined, in which beetles formed the major portion of the food. Winged termites, traces of ants and plant bugs, Hemiptera, were also found.

Family CUCULIDAE (Cuckoos).

Nine species of this family are recorded from Trinidad. Most of them are to be found in forest and cacao. *Tapera naevia* is parasitic, the host frequently being the "spine tail", *Certhiaxis cinnamonea*. The tick bird or Merle corbeau, *Crotophaga ani*, is one of the most familiar birds in all settled parts.

Tapera naevia (Linn).

This bird is common in second growth and neglected cultivation. The food of this species is very varied; caterpillars, fifteen from one stomach dragon flies, grasshoppers, a mantis and various fragments of beetles being found in the stomachs examined.

Crotophaga ani Linn.

The tick bird is one of the most conspicuous and most abundant cane field birds. See Williams (1922) for illustration. The birds are always seen in small parties and their squeaking cry must be familiar. A description of the nest as well as of the community laying of several females in one nest is given by Williams (1922) who also records stomach contents and includes references to other observations. In the present investigation five stomachs were examined, which yielded a great variety of insect food. The fact that this species seems partial to the

apparently distasteful "stink bugs" of the family Pentatomidae has been previously recorded. These bugs were found in three stomachs, one bird having consumed ten *Nezeara viridis*, and one Reduviid bug. Large Acridid grasshoppers; caterpillars both spiny butterfly larvae and cutworms, Noctuidae; beetle fragments, mostly weevils; crickets, Gryllidae; cockroaches, Blattidae; Phasmidae; Cicadidae; Phalangidae and Millepedes, Myriopoda, were also represented. The bird has also been observed to eat the noxious mole cricket, *Gryllotalpa*. The great tick bird, *Crotophaga major*, is very similar though larger, with a glossy plumage and a hoarse cry, and it is found only in the vicinity of water, rivers, and lagoons. The variety of food taken is even greater. Again the "stink bugs" *Nezeara viridis* were in evidence, and Jack Spaniards, *Polistes canadensis*, added to this apparently unpleasant diet. In addition birds eggs, nestlings, frogs and a not inconsiderable amount of vegetable matter, including grains of rice had been eaten by the birds available for examination.

Family FORMICARIIDAE (Ant Thrushes).

Ant thrushes are largely woodland birds. Two common species are considered here. All are notably insectivorous, but their diet is not confined to ants as their name would suggest.

Sakesphorus canadensis (Linn).

A common bird of mangrove swamps, where it may be seen searching for insects amongst the branches and foliage of the trees. The six stomachs examined contained caterpillars 40 per cent. and 30 per cent. of the total content in two cases, beetles, largely weevils, Curculionidae, and longhorns, Cerambycidae; spiders, flies, plant bugs, small moths and other unrecognisable fragments. Matter, possibly of vegetable origin occurred in one stomach.

Thamnophilus doliatus.

A common bird of all cultivated parts, its call, a series of falling whistles, may be heard everywhere, but the bird itself is very retiring and seldom seen. The male is conspicuously barred black and white, the female is a rich chestnut colour. In the five stomachs examined beetles were mostly in evidence weevils, Curculionidae; flea beetles, Chrysomelidae; click beetles, Elateridae; and beetles of the family Tenebrionidae. Also a few caterpillars, grasshoppers and ants, all more or less noxious insects.

Family FURNARIIDAE.

Certhiaxis cinnamomea (Gmelin).

The "spine tail" is a common little cinnamon coloured bird of all swamp areas. Williams (1922), gives a description of its nesting habits under the name *Synallaxis* spp., mentioning but not recognising the eggs of the parasitic *Tapera naevia*. This bird must be considered of some importance economically since a large part of its insect food is obtained in the rice fields. Four stomachs were examined and plant bugs, Heteroptera, figure rather largely in two cases. Caterpillars were much in evidence, and other food consisted of termites, cockroaches and small dragonflies.

Family TYRANNIDAE.

In this family are included the American fly-catchers, commonly called King birds or Tyrant birds. The family is a predominantly insectivorous one, and comprises some of the commonest and most useful of the colonies' birds.

Fluvicola pica (Bodd).

Commonly known as the "washer women", this is a most conspicuously marked black and white bird about the size of a sparrow. Specimens may always be found in the neighbourhood of ponds, canals and slow running rivers in open or cultivated districts. Williams (1922) describes the nest and eggs and illustrates the bird. This and the next species are frequently parasitized by the "cow bird", *Molothrus*.

The "washer woman" follows the larger drains into the cane fields, where it undoubtedly eats numbers of froghoppers, *c.f.* Williams (1922). In the three stomachs examined caterpillars formed the favourite food, eight in one stomach representing 95 per cent. of the food taken. A variety of other small insects, mostly small fragments of Homoptera and beetles formed the remainder.

Arundinicola leucocephala (Linn).

The "white headed widow" is frequently seen together with the last species, which it resembles in habit and size. The cock of this species however, is entirely black except for its pure white head. The hen is greyer. Williams (1922) gives a figure and describes the nest and eggs. The food of the five birds examined consisted entirely of insects. Dragon-flies filled one stomach, and the same formed 80 per cent. of the food taken by another bird. Caterpillars of various species figured largely in two others. Also grasshoppers, spiders and beetles of the family Cicindelidae, were found. Williams (1922) records froghoppers.

Pitangus sulphuratus.

The common Kiskadee is probably the most familiar Trinidad bird, though it may not be so generally known that there is another species, the "broad billed Kiskadee" *Megarynchus pitangua*, almost identical in plumage and also very abundant. This latter species may be recognised by the wide beak and complaining cry which is unlike the call of the common Kiskadee. Williams (1922) records nesting habits and several observations on the food of the common Kiskadee. Two stomachs were examined. Large grasshoppers, large caterpillars, and many beetles had been taken. The bird often feeds on the ground, when mole crickets are probably much eaten. This bird is however a very general feeder. Urich informs me that he has observed them to eat small ground lizards, *Ameiva*; and leaf lizards, *Anolis*, and upon several occasions to splash into water after small fish. In towns they feed on scraps and become very bold.

Tyrannus melancholicus.

Fortunately this useful fly-catcher is one of the commonest in the colony. Besides occurring in swamp and forest the grey headed Kiskadee is abundant in cane fields where it does an inestimable amount of good. Birds perched on some convenient telegraph wire or bamboo pole have been observed to dart down and catch the destructive "Large moth borer", *Castnia licus*. Four of the stomachs examined belonged to birds collected in woodland, so the great importance of this species is not stressed by these records. Various caterpillars, a large bee, grass-hoppers, cicadas and various other plant bugs had been eaten. Traces of fruit were also present. Another bird shot at Caroni had eaten a mass of Chrysomelid beetles, a few small plant bugs Pentatomidae, and a female ant, *Cephalotes atratus*. On the other side of the account, Urich points out

that individuals may become very destructive to hive bees. They may take possession of a convenient perch in the vicinity of the hive, and feed extensively on the incoming bees. Williams (1922) records the nest.

Elaenia flavogaster (Thunberg).

The previously recorded fruit eating habits of this species, Chapman (1895), were again noticed during the present survey. Out of six stomachs examined fruit was found in two. The rest of the food was composed of winged ants, beetles of the family Elateridae, Scarabaeidae and Curculionidae and fragments of Orthoptera and Hemiptera.

Muscivora tyrannus (Linn).

The scissor-tailed fly catcher is a migrant visiting the colony during the early wet season. The departure of the majority of the birds is approximately coincident with the "petit carême" or Indian summer around October. Stragglers however may be seen in the island throughout the intervening months. Numbers of these useful birds may be seen in the cane fields at rest on some elevated perch or even on prominent clods of earth on the ground. Still larger numbers amounting to hundreds of individuals travel to and fro each day between some of the mountain valleys and their roosts in the swamps. Though usually typically fly-catcher like in their habit of making short insect catching flights from a look-out perch, the "scissor-tail" will also make a prolonged flight when insects are numerous, twisting and turning in a way reminiscent of a swallow.

A swarm of flying termites proves a special attraction. A hundred or more birds may then be seen on neighbouring trees, taking it in turns to make these prolonged flights and catching the insects with an audible click of the beak. Sometimes the bird feeds on the ground. Seven stomachs were examined. Caterpillars were found in two, many being "corn ear worms", *Laphygma frugiperda*. Beetles of the families Carabidae, Elateridae and Chrysomelidae were found in six. Also plant bugs, mole crickets and grasshoppers. Seeds were found in two stomachs. Williams (1922), gives a wood cut and an interesting account of this bird.

Family HIRUNDINIDAE (Swallows).

Swallows feed entirely on insects caught on the wing, and large parties are frequently seen circling over cane fields. Five species have been recorded from Trinidad, Roberts (1934) and the four common species are considered here. *Iridoprocne albiventris* has been seen over the Caroni river, but no stomach records are available.

Hirundo erythrogaster (Boddaert).

The barn swallow is an abundant migrant from the north during the winter months, though some birds may be seen during most months. One stomach was examined, but as is usually the case with this family the contents consisted of finely divided fragments of chitin. Fly (Diptera) and dragon fly remains were however recognisable.

Progne chalybea (Gmelin).

This, the largest species, is dark blue above and white below the body. The throat and back are grey. Though common this bird is most usually seen around the coast, where it appears to nest on rocky promontories and islands. Four stomachs were examined, two contained moths, a large one almost filling one stomach. Zygopterid dragonflies had been taken by the two other birds, in one case these formed 60 per cent. of the total content. Heads of bees and plant bugs, Heteroptera, were also recognised amongst the abundant fragments of chitin.

Pygochelidon cyanoleuca (Vieillot).

The present species is smaller and slenderer, it is dark blue, except for the white under parts. Large numbers of this species are at times seen over cane, or sitting in rows along telephone wires. Six stomach examinations show a preference for small flying insects, beetles appearing in two cases and flying ant remains in two. Other Hymenoptera, Diptera, of the family Ortalidae, and small Homoptera also had been taken. These records agree closely with those of Williams (1922), who also records froghoppers.

Stelgidopteryx ruficollis (Bangs).

This swallow is known as Bangs' rough-winged swallow. It is common in most places, especially in the neighbourhood of earth cliffs and cuttings, because it nests in holes in such places. The species can be recognised by its brownish plumage. The six stomachs investigated yielded a varied assemblage of small flying insects. Winged ants of various species occurred in five, and in two cases these formed the bulk of the food. Other Hymenopterous remains found were mostly of small bees. Beneficial parasitic Hymenoptera such as Braconid and Chalcid flies had also been eaten. Beetles occurred in fragments in all stomachs, weevils, Curculionidae; and flea beetles, Chrysomelidae being recognised. A Syrphid fly and a "stink bug", Pentatomidae; were also recovered.

Family TROGLODYTIDAE (Wrens).

Troglodytes musculus.

The house wren must be a well known bird to every one, both on account of its domestic habits and sweet song. The single stomach examined indicates a mixed insect diet; Caterpillar remains 50 per cent. a single ant ten per cent., spider remains ten per cent., the remaining 30 per cent. being unrecognisable. Williams (1922), records nesting habits.

Family MIMIDAE (Mocking Birds).

Mimus gilvus.

The mocking bird as far as Trinidad is concerned appears to be confined to the artificial savannahs and lawns of St. Augustine and Port-of-Spain. The bird however is common in the woods of Tobago and little Tobago, where it has been observed feeding on palm berries. The soft thrush-like song of this bird cannot fail to attract attention. The single bird whose stomach was available for examination had eaten Geometrid caterpillars and one hard seed.

Family TURDIDAE (Thrushes).

Turdus nudigenis Lafresnaye.

Of the six species belonging to this family recorded from Trinidad, Roberts (1934), this is by far the commonest. The thrushes are more at home in the forests and cacao plantations, but this species may be found in areas of second growth and even in gardens in Port-of-Spain. A mixed animal and vegetable

diet had been taken by the five specimens examined. Caterpillars, mostly belonging to the family Geometridae, a moth, fragments of beetles, and traces of earthy matter, possibly representing earthworms made up the former, the vegetable matter remaining unidentified. Williams (1922), records the nesting habits under the name *Merula gymnopthalmus*.

Family MNIOTILTIDAE (American Warblers).

Geothlypis aequinoctialis was the only bird in this family collected. The two stomachs examined both contained caterpillars though fragments of chitin representing other insects were found in one. Williams (1922), has found this bird eating both adult and nymphal froghoppers.

Family FRINGILLIDAE (Finches).

The finches are typical of cultivated and waste land where there is an abundant growth of weeds and grass.

Though generally seed eaters, the Black Finch *Volatinia jacarina*, as was previously recorded by Williams (1922), also eats insects, one specimen examined having taken a spider and several small caterpillars. Another stomach contained the remains of beetles. A second species, *Saltator olivascens*, was also found in two cases to have taken an insect diet consisting of ants and weevils, besides the usual vegetable matter.

Other common, and apparently entirely vegetarian finches are *Sporophila intermedia*, *S. nigricollis* and *S. minuta*, the last is a particularly abundant little bird, easily recognised by its grey upper parts and brick-red lower parts.

Family THRAUPIDAE (Tanagers).

Thraupis episcopus.

This is the common blue bird. Williams (1922), records the nesting habits under the name *Tanagra cana*. The food taken is apparently a mixed diet of both animal and vegetable origin. One particularly interesting case of insect catching was witnessed in the Northern Hills, in which both this species and the next were taking part. At the time there was a large flight of winged termites, which was attracting a good assemblage of insectivorous birds. Among these, perched on the topmost branches of a convenient tree were a number of these Tanagers. In turn they would make a short flight out among the insects, snap one up, and return to their perch. Four stomachs were examined during the present investigation and matter of vegetable origin was found in two. The other two had eaten insects, namely a small beetle in one, and fragments of beetles and weevils in the other.

Thraupis palmarum.

The Palm Tanager is very much the same build as the last species, but may be distinguished by its dull olive green colour. The "cabbage palms", *Oreodoxa*, are especially attractive to these birds, and in the evenings parties may be seen collected on them to roost, uttering their peculiar squeaking twitterings. This bird is common in similar situations to the above. The present species appears to be more of a vegetarian than the blue bird. Ripening cashew fruit attracts numbers of them. All five stomachs examined contained fruit. Only one of these birds had taken a caterpillar; this record and the note above are the only insect eating cases noted. Williams (1922), records nesting habits.

Family ICTERIDAE (American Orioles).

Molothrus bonariensis.

The "Cow bird" has the unfortunate habit of laying its eggs in the nest of small birds, such as the wren *Troglodytes*; and the washer woman, *Fluvicola*. A pair, the glossy blue-black male, and the grey female, may often be seen near houses, in second growth and on rice lands. Nine stomachs were examined.

Although this bird eats a number of insects, it is certainly destructive to rice, as was indicated by Guppy (1914). The rice is not only taken in the field but also from mats when the grain is put out to dry. Three birds had almost filled their stomachs with whole and broken rice grains, a single caterpillar in one case, and a fragment of a beetle in another, being the only other food taken. Other vegetable matter was found in four other birds, but caterpillars formed the major portion of the food, though beetle fragments, a moth and a "stink bug", Pentatomidae, were also recorded.

Agelaius icterocephalus (Linn).

This bird is found in large flocks throughout swampy areas. The male is easily recognisable by its yellow head, the rest of the body being blackish. Williams (1922), records the nest and eggs. Urich (1917), has reported it as damaging rice seedlings, and in two of the seven birds examined a few rice grains were found in the stomach. The remainder of the food, however, consisted of insects, chiefly weevils, Curculionidae; cut worms, Noctuidae; and mole crickets, *Gryllotalpa*; all very noxious insects. Another specimen shot in the early morning on the Caroni swamp had eaten one ant, a dragonfly and a grasshopper, as well as a quantity of unrecognisable vegetable matter.

Leistes militaris (Linn).

The soldier bird is another common ground feeding bird of the swamps and wet savannahs. The male has a bright red breast and epaulets, and dark upper parts, the female is more sombre. During the evening this bird may frequently be seen fluttering upwards uttering a series of "peep, peep, peep", then as the peak of the flight is reached it half closes its wings and glides back to earth, with a long drawn out "chee". Though Guppy (1914) reports otherwise it would appear that this bird is largely insectivorous. The four stomachs examined contained only insect remains, amongst which fragments of beetles predominated. These were mostly small brown species of weevils, Curculionidae; and Scarabaeidae. Caterpillars had been taken by two birds, also a cricket and a spider, Lycosidae.

Icterus xanthornis (Gmel).

The "Corn bird" or as it is sometimes called the "Golden oriole" is a striking black and yellow bird common in savannah, mangrove swamp, and throughout the settled districts. The pendant nests are commonly seen in trees, Williams (1922). The bird is insectivorous, though some vegetable food was taken by two of the five birds examined. Caterpillars filled one stomach and had been eaten by three other birds. Fly maggots, including "rat tailed maggots", Syrphidae nearly filled another stomach. Other food taken included spiders, grasshoppers, and several kinds of small beetles.

Holoquiscalus lugubris (Swains).

The "Common black-bird" or "boat tail" appears to be confined to the western side of the island where it may be seen about the artificial savannahs and throughout the cane land. This bird is a ground feeder and is particularly fond of mole crickets and earthworms. It is usually very tame and large parties follow weeding gangs through the cane and catch the numerous insects disturbed. The blackbird has been several times recorded to extract froghopper nymphs from exposed spital masses. Only one stomach was examined, and this contained a out eleven caterpillars; one at least being a cutworm, Noctuidae. Beetles had also been eaten. Urich (1909) and Williams (1922) ecord feeding habits, and the latter also records the nest. This species is certainly one of the most beneficial, and its habit of following weeding gangs through the cane, catching disturbed insects and extracting froghopper nymphs from exposed spital suggests great possibilities. Large numbers are always to be seen around stock yards and it has been suggested that encouragement, such as feeding during the dry season, and the provision of shelter suitable for nesting sites in the neighbourhood would bring about an increase in numbers, and these would automatically take to the cane fields upon the appearance of the first brood of froghopper nymphs. See illustration Williams (1921).

Annotated List of References.

The following is not a comprehensive list of works on Trinidad birds, but all publications in any way connected with the food or economic status of the birds dealt with have been included. Works which in any way help in the determination of Trinidad birds have also been included.

Alexander, W. B.—Birds of the Ocean. G. P. Putman & Sons, N.Y. & London.

By means of this book which deals with the sea birds of the world, the coastal birds of Trinidad may be determined. A most useful book to take on a sea voyage.

Chapman, F.—*Bull. Amer. on Nat. Hist.* VI (1895).

Feilden, G. St. C.—*Bull. Dept. Agric. Trinidad and Tobago.* No. 13. pp. 25-33 (1914). Giving short descriptions of about 33 common birds, indicating food habits and recording nesting habits of some of the species.

Guppy, P. L.—*Bull. Dept. Agric. Trinidad and Tobago.* Vol. 13 (1914). Notes on beneficial and harmful birds, in cane and cacao. Notes distinctions between the smaller woodpeckers with the aid of descriptions and sketches.

Kershaw, J. C.—Dept. Agric., *Special Circular* No. 4, pp. 1 (1913).

Leotaud, A.—Oiseaux de l'ile de la Trinidad. Port-of-Spain (1866). Still the only comprehensive taxonomic work on Trinidad birds. The nomenclature is now hopelessly out of date. In French

May, J. B.—The Hawks of North America. The Nat. Assoc. of Audubon Socs. (1935). A beautifully illustrated book from which a large portion of the Trinidad species of "Hawks", Cathartidae and Falconidae, can be recognised.

Myers J. G. and Urich, F. W.—*Trop. Agriculture*, Vol. VIII, No. 4 (1931). Status of the Mongoose. *Ordinance, Royal Gazette Dec.*, 1933. (*No.* 35).

The latest ruling on wild bird protection.

Roberts, H. R.—List of Trinidad Birds with Field Notes. *Tropical Agriculture*, Vol. XI, No. 4 (1934). List of birds with brief field notes, collected in Trinidad in 1931. Some other records are included, but the list is not complete.

Smooker, G. D.—*Oologists Record*, Vol. VIII No. 3 (1928). Breeding species in a certain restricted area of bamboo plantation and swamp.

Sturgis, B. B.—Field book of Birds of the Panama Canal Zone. G. P. Putman Sons. N.Y. & London. A description of the habits, call, notes, &c. of the birds of the Canal Zone, for the purposes of identifying them. Many of the forms are allied to Trinidad species.

Urich, F. W.—The mongoose in Trinidad. Bd. Agriculture Trinidad and Tobago. *Circular* 12, (1914).

Urich, F. W.—*Bull. Dept. Agric. Trinidad and Tobago.* Vol. IX. (1909).
Food of *Holoquiscalus.*

Urich, F. W.—*Bull. Dept. Agric. Trinidad and Tobago.* Vol. XVI. (1917).
Food of *Agelaius.*

Williams, C. B.—*Mem. Dept. Agric. Trinidad and Tobago.* No. 1 (1921).

Brief notes on food of some of the commoner cane land birds, given more fully in the next publication.

Williams, C. B.—*Bull. Dept. Agric. Trinidad and Tobago.* Vol. XX. (1922).

A full account of feeding and nesting habits, and other notes of interest on about 100 species of the common birds. Key and description to the humming birds.

Belcher, C. and Smooker, G. D.—Birds of the Colony of Trinidad and Tobago. *Ibis*, July, 1934 and April, 1935.

ELEPHANT GRASS.*

A bulletin recently issued by the United States of America Department of Agriculture describes the climatic and soil requirements of Napier grass, or elephant grass (*Pennisetum purpureum*), the method of planting it and its utilization as a pasture or fodder crop. The outstanding features of elephant grass are its aggressiveness, heavy yield, high nutritive value and persistent growth over a period of years. It is best propagated by the use of stalk cuttings or root-clump divisions. Yields of 50 to 90 tons of green fodder per acre per year are readily obtained under favourable growing conditions. It may be successfully pastured if rotational grazing is practiced while under proper management a carrying capacity of ten mature beef animal per acre per year has been obtained. Elephant grass has a protein content similar to that of Sudan grass (*Sorghum vulgare* var. *Sudanese*) when cut at the proper stage for feeding as a grass fodder. Its crude fibre content is also similar but its ash content is considerably higher than that of Sudan grass.

* C. P. Wilsie and M. Takahashi. Napier Grass (*Pennisetum purpureum*) a Pasture and Green Fodder Crop for Hawaii. *Bulletin No.* 72 U.S.A. Dept. of Agriculture. From the Superintendent of Documents, Washington, D.C. price 5c.

INVESTIGATIONS ON SUGAR-CANE AND SUGAR-CANE SOILS IN ANTIGUA.

I.—PRELIMINARY RESULTS OF THE NEW EXPERIMENTAL SCHEME.

BY

P. E. TURNER, C. F. CHARTER AND F. H. S. WARNEFORD.

Introduction.

THERE are recorded in this paper a preliminary series of results obtained from a scheme of field experiments on sugar-cane inaugurated in 1933 under the auspices of the Sugar-Cane Investigation Committee of Antigua. The scheme is a consequence of a critical review of agricultural practices on sugar estates in Antigua, which has been published elsewhere (1).

Previous Field Experiments.

Manurial experiments on sugar-cane were commenced in Antigua in 1891 and continued until 1897. They were resumed in 1899, but were again discontinued in 1916. The results of these experiments have been reviewed by Warneford (2). On the whole, they gave rise to the conclusion that a dressing of 20 tons to the acre of pen manure provides adequate food for a crop of plant canes, and that the limited rainfall of the island renders it unremunerative to use larger quantities of pen manure or to use inorganic manures in addition. It was considered, however, that improved methods of preparatory cultivation might necessitate modification of this manurial treatment. Should pen manure not be available it was suggested that a dressing to the acre of two cwts. of sulphate of ammonia, one-half to one cwt. of sulphate of potash and one cwt. of basic phosphate or superphosphate might prove beneficial to plant canes on soils in good condition during years of average rainfall. For ratoon canes it was found that a dressing of readily available nitrogen, not exceeding 40 lb. to the acre, could lead to paying results in such years, but that little advantage was to be derived from the use of potash and phosphate with nitrogen.

The results of cultivation experiments laid down in 1909-10 suggested that tillage of ratoon canes gives rise to an increase in yield. Similar experiments laid down two years later gave indefinite results.

Variety trials have been carried out by Warneford (3) since 1931. They have led to the conclusion that the varieties B.H. 10(12), Ba.11569, B.726 and P.O.J.2878 are worthy of further test. The situation with regard to varieties in Antigua, as a result of Warneford's experiments, has been fully discussed by McIntosh (5).

The New Scheme of Experiments.

The new scheme of experiments is designed to make thorough and systematic inquiry, in the course of time, into the more fundamental agricultural practices in standard use on the main soil types of Antigua, and to compare their merits with alternative practices which have proved successful in Trinidad and elsewhere, due regard being paid to the untoward rainfall conditions which frequently obtain in Antigua.

A detailed description of the new scheme of experiments has previously been published (1). It includes experiments grouped under seven headings:—

Variety Trials.
Preparation of the Land for Planting.
Planting.
Cultural Methods after Planting.
Manuring.
Soil Amelioration.
Cultural and Manurial Treatment of Grassland.

The preliminary information which has been obtained under certain of these headings, may be gauged from the account which follows.

An Agricultural Classification of the Sugar-Cane Soils of Antigua.

A number of well-defined soil types occur in Antigua. They have been classified on a geological and physico-chemical basis by Hardy, McDonald and Rodriguez (6). The soil types differ very greatly in field behaviour. They undoubtedly require different cultural treatment and probably different manurial treatment. As frequent mention will be made of them in this paper, a brief agricultural classification of these soil types, which is in accord with their drainage and tillage characters, and which takes into account their suitability to the well-known variety B.H.10(12), is set out below.

Agricultural Classification of the Soil Types.*

(1) SOILS DERIVED FROM THE ANTIGUA AND SEAFORTH LIMESTONE FORMATIONS.

These soils comprise approximately 55 per cent. of the area under sugar-cane. They are fertile clays, black in colour. Although heavy in texture they are not difficult to work or drain, and they respond readily to suitable cultural treatment. The subsoil of this type consists of a brown transitional layer which immediately overlies the parent limestone.

For practical purposes these soils may be divided into three phases: shallow, deep and stony.

* By C. F. Charter and based on the classifications of Earle (10) and of Hardy, McDonald and Rodriguez (6).

(*a*) *Shallow phase.*—The topsoil in this phase is less than six inches deep. The phase occurs on hillsides and miniature plateaux. The shallow topsoil tends to dry out rapidly. In consequence young plant canes are liable to suffer severely, and mature canes to lose weight, in the dry season.

The variety B.H.10(12) cannot be successfully grown in the shallow phase.

(*b*) *Deep phase.*—The topsoil in the deep phase may penetrate to a depth of 15 inches. This phase occurs in valleys and in pockets in the limestone formation. Two rainfall zones may be distinguished in this phase.

(*i*) Zone of high rainfall, *i.e.*, greater than 40 inches per annum, in which the variety B.H. 10(12) can be successfully grown.

(*ii*) Zone of low rainfall, *i.e.*, less than 40 inches, in which B.H. 10(12) cannot be grown successfully.

(*c*) *Stony phase.*—This phase is comparatively unimportant. The soil is formed mainly from hard limestone and is usually shallow. It is not suited to the variety B.H. 10(12).

(2) Soils derived from the Siliceous Clays of the Tuff or Limestone Regions.

These soils comprise 35 per cent. of the area under sugar-cane. For practical purposes they may be separated into four sub-types:

(*a*) *Calcareous clay-tuff.*

(*i*) Zone of high rainfall (over 40 inches per annum) in which B.H. 10(12) can be successfully grown.

(*ii*) Zone of low rainfall (less than 40 inches) in which B.H. 10(12) is rarely successful.

(*b*) *Non-calcareous clay-tuff.*

(*i*) Abutting the upper gritty tuffs, and infertile. It is probably not possible to grow B.H. 10(12) with success on this soil.

(*ii*) Abutting the lower gritty tuffs, and including clays of gritty tuff origin. This soil is fertile. The rainfall is usually high and B.H. 10(12) can be successfully grown.

The fertility and field characters of the clay tuffs are largely dependent on their content of calcium carbonate. The non-calcareous tuffs are difficult to work and so far have given a poor response to cultivation. They readily become waterlogged and are difficult to drain. Root development in these soils appears to be superficial. The calcareous clay-tuffs are more permeable to water and more easily worked. They tend to resemble the deep phase of the soils derived from the Antigua and Seaforth limestone formations.

(*c*) *Lagoon clays* (including Montpelier clay, Cedar Valley clay, Vernon marls and Lindsey marls). The Vernon and Lindsey marls, which are the more important of the lagoon clays, are heavy, impermeable, deep clays, almost as difficult to work and drain as the non-calcareous clay-tuff soils. Their varietal characters are dependent on rainfall.

(*i*) Zone of high rainfall (over 40 inches per annum), in which B.H. 10(12) can be grown with success.

(*ii*) Zone of low rainfall (less than 40 inches), in which B.H. 10(12) fails.

(*d*) *Mixed limestone and lagoon clays.* These are more easy to work than the pure lagoon clays.

(3) Sandy Soils of Volcanic Origin derived from Basement Rocks or Lower Fertile Gritty Tuffs.

These soils which appear to be incipient tropical red soils, and are easily worked and drained, comprise approximately ten per cent. of the area under sugar cane. Two soil phases may be distinguished.

(*a*) *Shallow* (*or hillside*) *phase,* which tends to dry out rapidly, and is not suited to B.H. 10(12).

(*b*) *Deep* (*or colluvial*) *phase,* in which B.H. 10(12) can be successfully grown.

(4) Alluvial Soils derived from non-Calcareous Clay-tuffs (2B) and Sandy Soils (3A and 3B).

These soils occur over a comparatively small area. They resemble the wetter tuffs in general agricultural character, and can support B.H.10(12) successfully.

Rainfall.

Rainfall in Antigua is comparatively low and very irregularly distributed. On the average there is an alternation of wet and very dry seasons which coincide with the last and first six months of the year. Average figures for 70 recording stations, published by Hardy, McDonald and Rodriguez (6), are reproduced below.

Wet Season.		Dry Season.	
July ..	3.60 inches	January ..	2.45
August ..	3.66 ,,	February ..	1.91
September	4.54 ,,	March ..	1.96
October ..	5.33 ,,	April ..	2.43
November	5.15 ,,	May ..	3.06
December..	3.09 ,,	June ..	2.52
Total ..	25.37 ,,	Total ..	14.33

The wet-season figures can be deceptive in that a very considerable proportion of the rain falls in isolated and extremely heavy showers. The severity of the dry season is to some extent minimised on the clay-tuff soils, the lagoon clays and alluvial soils by their high retentive power for moisture, and on certain areas by heavy falls of dew.

Yield Data from the Preliminary Set of Experiments.

It should be noted that the majority of the preliminary experiments were unavoidably laid down late in the planting season. In consequence, maximum benefit could not be derived from the cultural and manurial operations under test (1). The late start also made it difficult in many cases to find suitable unmanured or unplanted experimental sites, and it was frequently found necessary to make the best of unsatisfactory conditions.

Variety Trials on Plant Canes.

BARBADOS SEEDLINGS AND P.O.J. 2878 (VIA)*.

The varieties recorded in Tables I, II and III were compared at the suggestion of McIntosh (4).

Table I.—A comparison of varieties under conditions of very low rainfall.

Soil type : Calcareous marl, deep phase (1 b).
Total rainfall (14¼ months) : 36 inches.
Estate : Thibous. *Layout :* Five randomised blocks.
Planted : 20/12/33. *Reaped :* 28/2/35.

Variety.	Yield (tons per acre).	
	Cane.	Sugar.
Ba. 11569	17.17	2.35
B. 2935	16.10	2.26
P.O.J. 2878	13.11	1.64
S.C. 12/4	10.65	1.33
B. 147 (B. 4507) ..	7.73	0.90

All the varieties germinated well and were established without difficulty, with the exception of B.147, in the experiment on the shallow marl soil.

A difference between any two mean yields of cane must exceed 5.62 tons for statistical significance. The yield of Ba.11569 is significantly greater than that of S.C.12/4 and of B.147. The yield of B.2935 is significantly greater than that of B.147.

The yields of sugar to the acre run closely parallel to the yields of cane. A difference of 0.76 tons of sugar to the acre is necessary for statistical significance. The varieties Ba.11569 and B.2935 give significantly larger yields of sugar to the acre than S.C.12/4 and B.147. The variety P.O.J.2878 takes an intermediate place in the list.

Table II.—A comparison of varieties under conditions of medium rainfall.

Soil type : Calcareous marl, deep phase (2b).
Total rainfall (14½ months) : 42 inches.
Estate : Collins. *Layout :* Four randomised blocks.
Planted : 28/12/33. *Reaped :* 12/3/35.

Varieties.	Yield (tons per acre).	
	Cane.	Sugar.
B. 2935	28.59	3.47
Ba. 11569	28.08	3.70
B.H. 10 (12)	26.30	3.84
P.O.J. 2878	25.24	3.61
S.C. 12/4	22.54	3.20
B. 147 (B. 4507) ..	22.28	2.79
B. 726	22.11	3.41

* The index numbers appended to the sub section headings refer to the place of the experiments in the general experimental scheme as originally planned (1).

The varieties B.147 and S.C.12/4 were difficult to establish, and made a poor start, in the experiment on the deep, marl soil.

A difference between any two mean yields of cane must exceed 4.79 tons for statistical significance. The yields of B.2935 and Ba.11569 are significantly greater than those of S.C.12/4 and B.726.

A difference of 0.49 tons of sugar to the acre is necessary for statistical significance. The variety B.H.10(12) rises from third place to first place when allowance is made for juice quality. It is then closely followed by Ba.11569 and P.O.J.2878. There appears to be little to choose, in this experiment, between the yields of sugar given by the varieties B.2935 and B.726 in spite of a large difference in yield of cane.

Table III.—A comparison of varieties under conditions of high rainfall.

Soil type : Non-calcareous clay tuff (2b).
Total rainfall (14½ months) : 50 inches.
Estate : Paynters. *Layout :* Four randomised blocks.
Planted : 9/1/34. *Reaped :* 21/3/35.

Varieties.	Yield (tons per acre).	
	Cane.	Sugar.
B. 2935	32.96	4.57
Ba. 11569	30.48	4.18
P.O.J. 2878	29.70	3.93
S.C. 12/4	29.37	4.18
B.H. 10 (12)	26.95	4.35
B. 726	26.30	3.97
B. 147 (B. 4507) ..	25.25	3.05

It was found exceptionally difficult to establish B.H.10(12) in this experiment.

A difference between any two mean yields of cane must exceed 3.66 tons for statistical significance. The yield of B.2935 is significantly larger than that of B.H. 10(12), B.726 and B.147. The yields of P.O.J.2878 and S.C. 12/4 are significantly larger than B.147. The yield of Ba.11569 is significantly larger than that of B.726 and B.147.

A difference of 0.56 tons of sugar to the acre is necessary for statistical significance. It is of interest that the variety B.H.10(12) rises to the second place in the list, and that P.O.J.2878 drops to sixth place, when quality of juice is taken into account. The variety B.726 gave a significantly smaller yield of sugar to the acre than B. 2935.

General Comments on the varieties under comparison.

Ba.11569 appears to be the nearest approach of the established varieties to a general purpose cane in Antigua. It germinates indifferently, but it is probable that this drawback can be overcome by soaking in lime-saturated water.

McIntosh (5) considers that Ba.11569 might replace B.H.10(12) with advantage on lagoon marls and non-calcareous clay tuffs, on account of its greater power to ratoon.

B.2935.—This variety germinated well in all three trials. It is likely to compete with Ba.11569 on the marl soils, provided that it gives satisfactory yields of ratoons.

P.O.J.2878.—It is doubtful whether this variety is suited to Antiguan conditions. To give high yields as plant canes it requires during the early stages of growth a more continued supply of moisture than is generally available. The growth of ratoons can also be seriously curtailed by the shortness of the wet season, even though they spring with exceptional vigour under the difficult soil conditions which in general obtain. The variety appears more suited to the alluvial soils and to the very calcareous clay-tuffs than to the other soil types.

B.H.10(12) is capable of giving satisfactory yields of cane and sugar on the more fertile, heavy clays, provided that drainage is good and that the annual rainfall exceeds 40 inches. On poorly drained clays it readily succumbs to root disease and fails to ratoon satisfactorily.

S.C.12/4.—This variety can make excellent growth under conditions of low moisture but it shows a marked tendency to become pithy and to dry out during the crop season. It ratoons indifferently even after giving good yields as plant canes.

B.726.—This variety germinated fairly well, and was established without difficulty in the experiments on the marl and clay-tuff soils. McIntosh (5) doubts whether B.726 has been tested under its optimum growth conditions in variety trials in Antigua.

B.147 (B.4507).—This variety is commonly called B.4507 in Antigua, but there is good reason to believe that its proper designation is B.147. Its performance in the experiments on the marl soils do not give a true indication of its field value, for it can give high yields under estate conditions.

The germination of this variety is uncertain and its early growth is slow, but treatment of the setts with lime-saturated water for 48 hours before planting has been found to overcome these drawbacks*. Its resistance to drought, its excellent ratooning power, and its heavy fall of trash in many ways suit it to the light marl soils which dry out rapidly, and on which it is usually grown. It is definitely unsuited to the clay tuffs, the lagoon marls and the alluvial soils.

Hardy Canes *v* Noble Canes (VIb)

Thick canes ratoon indifferently on the infertile, non-calcareous clay-tuff soil. An experiment has therefore been laid down to compare on this soil type the hardy variety Co.213 with the thick canes P.O.J.2878 and B.H.10(12). Yield data for the plant canes are recorded in Table IV. The main interest of this experiment will lie in the yield of ratoons.

* C. F. Charter.—An unpublished communication.

Table IV.—A comparison of varieties on an infertile soil (plant canes).

Soil type : Upper clay-tuff, non-calcareous, relatively infertile (2b).
Total rainfall (16½ months) : 54 inches.
Estate : Paynters. *Layout :* Four 3×3 Latin squares.
Planted : 10/12/33. *Reaped :* 26/4/35.

Variety.	Yield (tons per acre).		Tons cane per ton sugar.
	Cane.	Sugar.	
Co. 213 ..	22.95	2.76	8.33
P.O.J. 2878..	22.17	2.82	7.87
BH. 10 (12)	20.73	3.00	6.90

For the plant canes, the yield of the variety Co.213 and of P.O.J.2878 significantly exceeds that of B.H.10(12). The variety B.H.10(12), however, has given the largest yield of sugar to the acre.

The varieties Co.213, P.O.J. 2727 and Ba.11569 also are under comparison on a shallow limestone soil. Yield data for the plant canes are set out in Table V.

Table V.—A comparison of varieties on a shallow, limestone soil (plant canes).

Soil type : Light calcareous loam, overlying crumbly porous marl (1a).
Total rainfall (16½ months) : 50 inches.
Estate : Blizzards. *Layout :* Four 3×3 Latin squares.
Planted : 12/1/34. *Reaped :* 24/5/35.

Variety.	Yield of plant canes (tons per acre).
Ba. 11569	30.01
P.O.J. 2727	25.10
Co. 213	25.40

The larger yield of plant canes in favour of the variety Ba.11569 might be due to chance less than once in 100 times.

Preparation of the Land for Planting.

Cross-holing *v* Open Furrows (Id).

It is still customary in large areas of Antigua to form bars of earth (cross-bars) at regular intervals across the furrows. The cane is planted in the cross-holes thus formed.

The demerits and merits of the practice of cross-holing have previously been described (1). Water can lie in pools in cross-holes for long periods on heavy soils, and can cause considerable damage. Before planting the stagnant water can minimize the good effects of ploughing. After planting it can prevent germination, or cause the death of the young plant. The plant can continue to live in a pool of water after it has passed through the more susceptible stages of early growth, but it remains liable to root diseases

which may cause serious losses in yield. Stagnant water lying around the base of the plant can also prevent it from making full use of the fertility of the soil and of manures.

In favour of the practice it is stated that cross-holes form natural receptacles for water from occasional showers during dry periods. In Table VI there are recorded data which give a measure of the consequences of cross-holing on yield of plant canes under conditions which should lend emphasis to any such beneficial effect. The yield data are mean values for 16 replicates of the individual cultural treatments.

Table VI.—Effect of cross-holing on yield of dry-season plant canes.

Soil type : Calcareous clay-tuff (2a).
Total rainfall (13¼ months) : 42 inches
Variety : Ba. 11569.
Estate : La Roches. *Layout :* Randomised blocks.
Planted : 4/4/34. *Reaped :* 9/5/35.

Cultural Treatment.	Yield of cane (tons per acre).
Open furrows	30.04
Cross-holed furrows ..	28.72
Loss due to cross-holing ..	1.32

The experimental area was not planted until the second half of the dry season. Consequently the yield data do not give a measure of the adverse effects which water-logging, due to cross-holing, can have on wet-season plants during the critical period of early growth prior to the dry season.

During the first four months after planting the rainfall was as follows :—

April, 0.16 inches. May, 1.15 inches.
June, 2.84 inches. July, 2.41 inches.

In view of the low rainfall, cross-holing might be expected to lead to improved germination and more rapid growth, if cross-holes aid in moisture conservation during dry periods. Measurements of germination, made 45 days after planting, showed that cross-holing had no effect on germination on the experimental area.

The data set out in Table VI indicate that cross-holing had an adverse effect on yield. Such an adverse effect could result from water lying in the cross-holes during the wet season of 1934, *i.e.*, during the later and less susceptible period of growth. The difference of 1.32 tons in favour of open furrows, however, cannot be established as statistically significant.

In this experiment the rainfall conditions which prevailed at the time of planting, and during the period of early growth, would in general be considered as propitious to the practice of cross-holing. Nevertheless the practice did not have a beneficial effect on yield.

Planting.

Distance of Planting (IIb).

Of recent years there has been a tendency in Antigua to plant more closely than is customary in the other West Indian islands.

The data recorded in Table VII give a measure of the effect under Antiguan conditions of varying the spacing distance. In this experiment the distance between the rows of plants was maintained constant at 4½ feet on all plots. The distance between the plants within the row ranged from two to four feet.

Table VII.—Effect of distance of planting on yield of plant canes.

Soil type : Calcareous marl, shallow phase.
Total rainfall (14¾ months) : 36 inches.
Variety : Ba. 11569.
Estate : Thibous. *Layout :* Four 3×3 Latin squares.
Planted : 1/12/33. *Reaped :* 26/2/35.

Distance of planting (within rows).	Yield of cane (tons per acre).
2 feet	17.28
3 feet	17.58
4 feet	16.47

The rainfall during the life of the plant canes was very low and very unevenly distributed. Of the total of 36 inches, 4.5 inches fell in August, 7.9 inches in November and 4.7 inches in December.

The yield data suggest that no gain results from planting closer than four feet within the row under the conditions of the experiment.

It will be shown elsewhere that in the dry districts of St. Kitts a steady increase in yield can result as the planting distance in the row is increased from two feet to four feet, and that in the wet districts of this island no gain in yield may result by planting closer than four feet.

Cultural Methods after Planting.

The Breaking of Banks (IIIa).

It is not customary in Antigua deliberately to return the earth from the banks into the planting furrows during the life of the plant canes. The advantages which may accrue from this operation which is termed 'the breaking of banks', when performed in a suitable manner and at a suitable time, have previously been discussed (1). The more important benefits may be summarised as follows :—

(1) The operation brings into closer proximity with the root system of the young plant the cultivated topsoil from which the banks are formed and the pen manure and decomposed trash which the banks contain.

(2) If the operation can be performed before the end of the wet season it provides an earth mulch around the base of the young plant which acts as a protective blanket during the dry weather which follows.

(3) It prevents water lying stagnant in the furrows or cross-holes around the base of the young plant in wet weather.

Yield data obtained from two experiments laid down to obtain a measure of the effect on yield of the operation of breaking of banks are set out in Table VIII. There were 18 replicates of the two cultural treatments in each experiment.

Table VIII.—Effect on yield of the operation termed 'breaking of banks'.

Soil type : Alluvial (4).
Total rainfall (16 months) : 43 inches.
Variety : B.H. 10 (12).
Estate : Blubber Valley.
Layout : Latin square.
Planted : 5/1/34.
Banks broken : 14/5/34.
Reaped : 2/5/35.

Cultural treatment.	Yield of plant canes (tons per acre).
Banks broken	16.78
Banks left unbroken ..	17.40

Soil type : Calcareous clay-tuff (2a).
Total rainfall (12¾ months) : 39 inches.
Variety : Ba. 11569.
Estate : Cochranes. *Layout :* Latin square.
Planted : 29/3/34. *Banks broken :* 3/8/34.
Reaped : 23/4/35.

Cultural treatment.	Yield of plant canes (tons per acre).
Banks broken	37.64
Banks left unbroken ..	37.26

Neither of these experiments give a true measure of the value of the operation. One experiment was not planted until January, and the other not until March. In consequence the plants were not adequately grown for banks to be broken until after the dry season. The mulching value during the dry season and the early manurial value of the operation were therefore completely lost.

The conditions which obtain in Antigua at the present time make it difficult for maximum benefit to be derived from the breaking of banks. Planting is commenced very late, on the average. Soil conditions appear to encourage the continued growth of a single mother shoot, rather than the early appearance of a number of shoots. With the variety B.H. 10 (12), for example, active formation of tillers does not commence until three months after planting, that is, some time after the advent of the dry season. The yield of this variety would probably be greatly increased if a number of tillers of approximately equal age could be induced to appear before the end of the first wet season, thus enabling banks to be broken before the soil dries out, the optimum time for this operation. Early tillering is in large extent dependent on methods of cultivation, drainage and manuring, all of which are under investigation in the experimental scheme.

In Antigua the furrows in which the setts are planted are made unusually deep. The banks between the furrows therefore contain a very large volume of earth. In consequence breaking the banks before the dry season may cause a serious set-back in growth by choking the young tillers which are in the process of formation and by forcing the development of a new zone of tillering which is nearer to the surface of the soil. In view of the character of Antiguan soils it is doubtful whether any advantage is derived from such deep furrowing, apart from the delay to which it leads in the breaking of banks.

[*The preliminary information obtained from the manurial experiments will be discussed in the next issue.*]

REVIEWS.

A DICTIONARY OF THE ECONOMIC PRODUCTS OF THE MALAY PENINSULA, Vol. I (A-H), Vol. II (I-Z).

By I. H. Burkill, M.A., F.L.S. *Crown Agents for the Colonies*, London, 1935. pp. 2402 + xi, 30*s*.

It would be difficult to review a book of this title without some reference to Watt's monumental "Dictionary of the Economic Products of India". There is no reason for the attempt to do so, since the author himself in his preface suggests the parallel. Let it therefore be said at once that the "Dictionary of the Economic Products of the Malay Penninsula" is thoroughly worthy to take its place beside its great model.

The comparison is useful, because all readers with any interest in a reference book of this type must be acquainted with the older work, and will understand without further description the general scope of the present one. Emphasised to a point at which it conveys the faintest suggestion of plagiarism, comparison at once becomes unfair. The volumes before us own their worth to the diligent observation, wide scholarship and critical ability of their author, and not to any model.

Mr. Burkill has had the assistance of four specialist collaborators, named on the title page, and acknowledges the help of many other authorities, but the great bulk of the work is his own, and we are not surprised to read that twenty-three years of labour have gone to the compilation of its 2,400 pages. To the courage that can face such a task, and to the perseverance necessary for its consummation, no tribute can be too high. The debt of gratitude which the scientific world owes to those who systematize knowledge is too seldom formally recognized, but one form of practical recognition will not be

wanting. The value of systematic works of this kind is by no means confined to the regions with which they specifically deal. All round the world, and especially between Cancer and Capricorn, the "Dictionary of the Economic Products of the Malay Peninsula" (predestined to be shortened in every day speech to "Burkill") will lead a restless existence on (and off) the shelves of scientific libraries for many years to come.

A noteworthy feature is the prominence given to Malay lore and customs on almost every page, much of it the result of careful personal observation in the country. The longer articles, such as those dealing with major crops, are excellent up-to-date summaries, though necessarily relatively brief, of the general botany of the species concerned and of their economic problems.

"Burkill" has one drawback as a reference book. The busy botanist, turning up a particular genus, is sure to have his eye caught on the way by some item quite irrelevant to his purpose but much too interesting to be left unread, and he will be very busy, or super-conscientious, if he succeeds in tearing himself out of the clutches of the Dictionary within the next half-hour. Probably this fatal fascination will wear off when we have handled the book for some months, but the sober fact will remain that its entries are readable to an extent almost surprising in a compilation of its kind.

With the assurance that the serious purposes of the Dictionary will be duly appreciated, we cannot resist two examples picked at random to illustrate the spice of humour that renders the solid fare so much more digestible. Under *Myristica fragrans* (which has six pages devoted to its history, botany and uses) we find: "A curious use for a nutmeg is given by Wray (*Perak Mus. Notes*, No. 3 of Vol. I. 1894 p. 43). For colouring the blade of a kris prepare 'warang masak' thus: take 12 cloves, 15 peppercorns six bird peppers, one nutmeg and a piece of the root of *Plumbago rosea* of the size of half a nutmeg. Grind them and put them into a cup with the juice of 1½ limes. Allow to stand and then strain, and add the fluid to a half drachm of powdered arsenic, boil and then apply. The effect of the nutmeg, if any, must be insignificant". And under Snakes, *inter alia*, "Sir Hugh Low says of snake fat, that the more venomous the snake, the better do the Malay women of Sarawak consider the fat to be for the hair".

As a general rule the headings of the subjects are their scientific names, and instead of a cumbrous system of cross references an index has been adopted for the English and Malay names. This alone occupies 94 double-column pages of small type and represents a formidable undertaking, almost a dictionary within a dictionary. As planned it can be used to find the scientific equivalent of a vernacular name without reference to the text.

The printing is by the Oxford University Press, which is sufficient tribute to its quality. The binding of the volumes sent for review, however, leaves something to be desired in that the covers seem likely to come off rather soon. This small criticism is mitigated by consideration of the very low price of the work, relative to its content, and if libraries where it is in constant use have to rebind it (perhaps making four volumes instead of two) it will still be inexpensive.

E.E.C.

* * *

COLLOIDS IN AGRICULTURE.

By C. E. Marshall. *Edward Arnold & Co.*, London, 1935. pp. 184, 5*s*.

The rapid development in recent years of agricultural chemistry has chiefly been due to a clearer understanding of the nature, properties and behaviour of substances occurring in the colloidal state. Colloidal substances play an important part in the soil, most of whose reactive properties and ability to supply nutrient materials at a steady rate are due to its content of colloidal clay and colloidal humus. In the animal and in the plant, colloidal substances (such as starch, cellulose, gums, mucillage and proteins) largely control the processes resulting in growth, and it is only through knowledge of the properties and relationships of these organic colloids that a proper appreciation of the mechanism of growth can be gained. Furthermore, the profitable manufacture of plant and animal products from natural sources (such as sugar from cane juice, rubber from latex, butter and cheese from milk) depends partly on the application of the principles of colloidal chemistry and physics.

In this book, Dr. Marshall, of the University of Leeds, England, has set himself the task of summarising and arranging some of the facts and theories of colloid science in their bearing on agricultural problems. He divides his subject matter into (1) a description of the realm of colloids, (2) colloids in soil, and (3) colloids in plant and animal life. The treatment is concise yet connected and interesting. Throughout, the needs of the instructor in farming and of the student of agriculture are especially considered. It cannot be expected that every aspect of colloid science is equally stressed in a book of this small compass, but the selection of material has been carefully made, with satisfying results. The book can be recommended as likely to fill a gap in the students' library. The author deserves the thanks of agricultural teachers for his conscientious effort to help them. Dr. Marshall has made several recent contributions to our knowledge of some of the more elusive properties of colloidal clay, and he is well aware of the great difficulties that beset the agricultural student, whose courses, of study embrace many diverse subjects requiring careful co-ordination and the stressing of fundamental principles. A true appreciation of underlying generalisations furnishes the only satisfactory means of acquiring lasting knowledge that will be of future service in the business of agriculture.

F. H.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Adaption of the *SJM* Formula for use in Queensland.—*P. J. Phelan.*

In the form in which it is generally used the Winter-Carp formula has little relation to actual Queensland practice as it is based on a molasses purity of $\frac{0.4}{1.4}$ or 28.57 per cent.; but the *sjm* formula is not an empirical formula; it may be derived from first principles, the only necessary assumption being that there is no accidental loss of material during manufacture. In Queensland the monetary evaluation of sugar is based on a 94 net titre standard; consequently for local purposes it is convenient to modify the recovery formula in order to determine recovery in terms of this standard, which can be done in the following manner:—

Recovery of pure sucrose

$$= \frac{s\,(j-m)}{j\,(s-m)} \times \text{sucrose in intermediate product.}$$

$$= \frac{s\,(j-m)}{j\,(s-m)} \times B \times j \quad .. \quad .. \quad .. \quad (1)$$

Recovery of pure sugar

$$= \frac{l}{s} \times \frac{s\,(j-m)}{j\,(s-m)} \times B \times j$$

$$= \frac{(j-m)\,B}{s-m} \quad .. \quad .. \quad .. \quad (2)$$

When s = purity of sugar; $j \times$ purity of intermediate product; m = purity of final molasses; and B = brix of intermediate product.

The tons of dry sugar of purity s recoverable from 1,000 gallons of intermediate product may now be calculated according to the following equation:

$$\frac{10 \times \text{Sp. Gr.} \times 1000}{2240} \times \frac{(j-m)}{(s-m)} \quad .. \quad (3)$$

Where Sp. Gr. is the specific gravity corresponding to the Brix B.

From which it follows that the tons of sugar of Brix Bs, and purity s, recoverable per 1,000 gallons of intermediate product is equal to:—

$$\frac{10 \times \text{Sp. Gr.} \times 1000}{2240} \times \frac{(j-m)\,B}{(s-m)\,Bs} \quad .. \quad (4)$$

With sugar of constant composition, and molasses of fixed purity, the only variables in this expression are B, Sp. Gr., and $(j-m)$, and if definite values for B be taken $(j-m)$, becomes the only variable. By the use of this simplification equation 4 assumes a form suitable for the compilation of tables, particularly when calculating machines are available.

A portion of equation 4, viz., the fraction: $\frac{10 \times 1000}{2240\,(s-m)\,Bs}$ remains constant throughout; this value is utilized in computing factors for variable values of Brix. For example, if the molasses purity be taken as 44, and the purity and brix of 94 n.t. sugar be taken as 97.9 and 99.3 respectively, then:—

when $B=70$ the factor is 7.86567
" $B=80$ " 9.42000
" $B=90$ " 11.10993

Assuming that the purity of the intermediate product may range from 50-94 (*i.e.*, the value j ranges from 0.5 to 0.94), then

when $j=0.5$ $(j-m)=0.06$,
$=0.51$ " $=0.07$,
$=0.52$ " $=0.08$, and so on.

The tons of 94 n.t. sugar recoverable from 1,000 gallons of intermediate product may now be quite simply calculated by multiplying the factor corresponding to the particular Brix by the calculated value for $(j-m)$. Thus with a Brix of 70 (factor = 7.86567),

when $j=0.05$ (50 pur.), Recovery $=0.47$
" $j=0.51$ (50 pur.), " $=0.55$
" $j=0.52$ (52 pur.), " $=0.63$

tons 94 n.t. sugar per 1,000 galls.

Values for other Brix readings are calculated in an exactly similar manner, and the table extended for other molasses purities until a sufficiently wide range is obtained. True purities are required, but sufficiently accurate values may be computed from apparent purities by the use of a conversion factor.—(*Int. Sugar Jl.*, Vol. XXXVII, No. 443, 1935, pp. 451-52.)

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Deterioration of Cut Sugar-Cane in Egypt.

Although the loss in sugar value of the cane during a delay between harvesting and milling has been mentioned by investigators in other sugar-producing countries, the observations made by Dr. Rosenfeld in the Egyptian field cannot be over-emphasised from the planter's point of view (Bull. 155, Ministry of Agriculture, Egypt). Certainly the fact that a four days delay in delivering the cut cane means the evaporation of all the profits on the harvest serves to give point to the investigations at Mallawi. Though the extent of loss varies with the type of cane grown, yet in no case is it small enough to make a delay in delivery anything but a serious risk—even in the coolest harvest time when deterioration is least. At the same time, in cases of unavoidable delay, certain elementary precautions will minimise the loss. Of the actual manner of deterioration, the 'masking' of the remaining sucrose by the invert sugar, glucose, is perhaps the most interesting, for it means that loss is not only due to inversion but also to the formation of the glucose on the sucrose crystals, so that the latter cannot be extracted. From the facts put forward it seems that a delay in harvesting, until immediate transport of the cut cane is assured, is at any time preferable to a hold-up between the harvest and delivery of the cane.—(*Nature*, Vol. CXXXVI, No. 3444, p. 725, 1935.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Water Requirements of Indian Crop Plants.

Following the methods of the American investigators, Briggs and Shantz, Professor B. N. Singh and two research students, R. B. Singh and K. Singh, have examined the water requirements of fifty-seven species and varieties of cereals cotton, sugar-cane &c., when grown at the experimental station of the Institute of Agricultural Research, Benares Hindu University (*Proc. Indian Acad., Sci.*, 1, No. 9, March 1935). The plants are grown in pots with carefully controlled water supply and, in the end, the total water transpired is divided by the dry weight produced, the roots being included in the yield, as was not done by the American experimenters. The amount of water available in these experiments seemed to control the yield of the varieties; the most efficient varieties, it is concluded, have a relatively short life-cycle when the use of water is reduced to a minimum. It is suggested that, under Indian conditions, these efficient varieties should be grown so that the number of irrigations might be controlled and thus the cost of production diminished. In their demand for water, sugar-cane crops proved most greedy, and then in order came tobacco, cotton, rice, potato. Other cereals, wheat, oats, barley, as also linseed, pea and mustard, had a much lower water requirement.—(*Nature*, Vol. CXXXV, No. 3426, p. 1080, 1935).

* * *

Germination of Lime Seed.

A very full study of the factors involved in securing prompt and abundant germination of the seeds of the lime is reported upon by J. Nelson Spaeth in Memoir 169 of the Cornell University Agricultural Experiment Station. His conclusion is that the pericarp is not important in delaying germination, but must be removed in order to treat the seed coat. Its removal is difficult because it is tough and leathery whilst the seed coat is hard and brittle. Seeds may be extracted by partially digesting the pericarp with concentrated nitric acid. Delay in germination is due to the impermeability of the seed coat; the water-excluding property depends apparently upon the compactness of the cellulose in the outer part of the palisade tissue of the seed coat, and treatment with concentrated sulphuric acid for 10 to 30 minutes renders the seed coat permeable without injuring the embryo within. In view of the factor causing impermeability, the important result follows that air-dry storage, which dries this impermeable cellulose layer, increases this impermeability, and as a result air-dried seeds after several years storage will remain impermeable to water for some years when placed in stratification.—(*Nature*, Vol. CXXXV, No. 3419, p. 796, 1935.)

"Toxin X".

In *Chemistry and Industry*, Vol. LIV, No. 31, p. 717, C. W. Green suggests the presence in foodstuffs of a group of substances which he calls "Toxin X". These toxic substances can be detected by the physiological effects produced by the consumption of liberal quantities of the specified foods over a period which may vary from a few days to a few weeks. The effects referred to are (1) the production of bilious conditions (2) inflammation of mucous membranes (3) predisposition of ordinary body tissue to sensitive and painful conditions (4) marked interference with normal digestive, assimilative and excretory processes.

"Toxin X" is a group of chemical substances of unknown chemical composition, and it is believed to occur in the following foodstuffs:—whole-grain cereals, tea, coffee, cocoa, fruit of all kinds picked before maturity, cucurbitaceous and certain other vegetables picked before maturity, all kinds of beers and also malt extract, yeast extract, honey, brown sugar, treacle, golden syrup, nuts of all kinds, and olive oil. The amount of toxin X present in tea appears to be in inverse ratio to the percentage of tannin it contains. The more select and expensive teas, reputed to have a low tannin content, are extremely rich in toxin X, while certain of the moderately priced Ceylon teas, containing a fair amount of tannin, contain negligible amounts of the toxin. It is noteworthy that two of the richest sources of vitamin B, namely malt extract and yeast, are very rich also in their toxin X content.

Mr. Green happens to be extremely sensitive to foods, and he has used this faculty as a test for the presence of the toxins which he groups together under this sinister title. In these days of micro-analysis and biological tests it is refreshing to think that the human laboratory may ultimately come into its own as the most sensitive means of detection. However, he refers to the fact that Prof. Stockman and Dr. Johnston, working in Scotland, have obtained from cereals certain toxins which produce in monkeys the effects usually attributed to vitamin deficiency. This work has been supported by the discovery by Dr. and Mrs. Mellanby that cereal toxins can be looked upon as a cause of dental decay. Although Mr. Green's results should not be taken too seriously at present, one cannot but admire him for suffering so much internal discomfort in the cause of Truth. It may well be that one day we shall be free from the too-common clinical diagnosis that "he must have eaten something that disagreed with him".

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
31st October ..	4 11¼	8 7¼
7th November ..	4 10½	8 7½
14th November ..	4 9¾	8 6¾
21st November ..	4 10½	8 7½
28th November ..	5 0	8 9¾
5th December ..	5 0¾	8 9
12th December ..	5 0¾	8 9
(13*th December*, 1934)	4 3¾	8 0¾

On the whole prices have been very steady and the market seems to carry more confidence. Supplies of raw sugar are firmly held and sparingly offered. Attention has been directed to the possibility of an international sugar conference being held this year, the main purpose of which is to raise the world price level to a figure corresponding more closely to the cost of production.

* * *

BANANAS.—Reduction in supplies and an increase in demand have resulted in a rise of £3 per ton, Jamaicas being quoted at £20 5*s*. per ton delivered London and £20 nearest station provinces. Brazilians are quoted at £16 per ton.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
30th October	6 1-2
6th November	6 7-16
13th November	6 5-16
20th November	5 3-16
27th November	5 5-16
4th December	6 1-4
11th December	6 3-8
(12*th December*, 1934)	6 3-13

Prices have generally been firmer except for a temporary set back due to a report that the Dutch authorities are claiming an addition to their basic quota under the restriction scheme on the ground that the Netherlands East Indies has been assessed at too low a figure. There has been a steady demand from America where total consumption for October at 42,436 tons exceeded all estimates.

* * *

COPRA.—Prices generally are about steady but West Indian f.m.s. is 5*s*. lower at £14 10*s*. c.i.f. London.

COCOA.—Since last writing the market for West African descriptions has been very steady being controlled by the Gold Coast position with buying competition between the manufacturing interests and the leading shippers. Until some of this purchasing, therefore, is finished, prices of Accra are likely to be kept steady. One could buy new crop Accra at 22*s*. 6*d*. c.i.f. London and locally $6.00 per fanega is paid for Plantation Cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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COFFEE. This market continues quiet with prices about steady. Robusta is quoted at 40*s*. to 45*s*. per cwt. and Superior Santos at 37*s*. per cwt.

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COTTON. The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
25th October	6.47	9.11
1st November	6.45	9.28
8th November	6.47	9.57
15th November ..	6.77	9.77
22nd November	6.77	10.03
29th November	6.66	—
6th December	6.67	—
13th December	6.45	—
(14*th December*, 1934) ..	7.08	8.97

The general tone of the market for American has been quiet. Consumption, however, is steadily increasing. Prices for both Sakel and Upper Egyptian have advanced following active buying in Alexandria prompted by political considerations. West Indian Sea Island continues in good demand with limited business done at from 16*d*. to 18*d*. per lb.

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LIME PRODUCTS.—*Lime Oil.*—Handpressed is in rather better supply; the value is 35*s*. to 37*s*. 6*d*. per lb. Distilled is firm with sales at 22*s*. 6*d*. and further supplies at the price.

Lime Juice.—Concentrated is valued at £4 15*s*. Raw is steady at 2*s*. to 2*s*. 6*d*. per gallon.—(*West India Committee Circular*, 21st November, 1935.)